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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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THE INSTITUTION OF ELECTRICAL ENGINEERS

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VOLUME 57 **SEPTEMBER 1954** NUMBER 681

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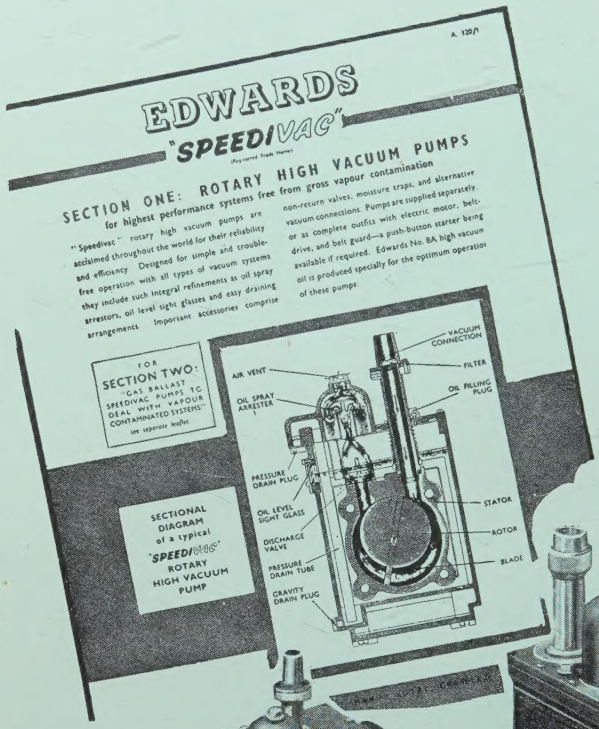
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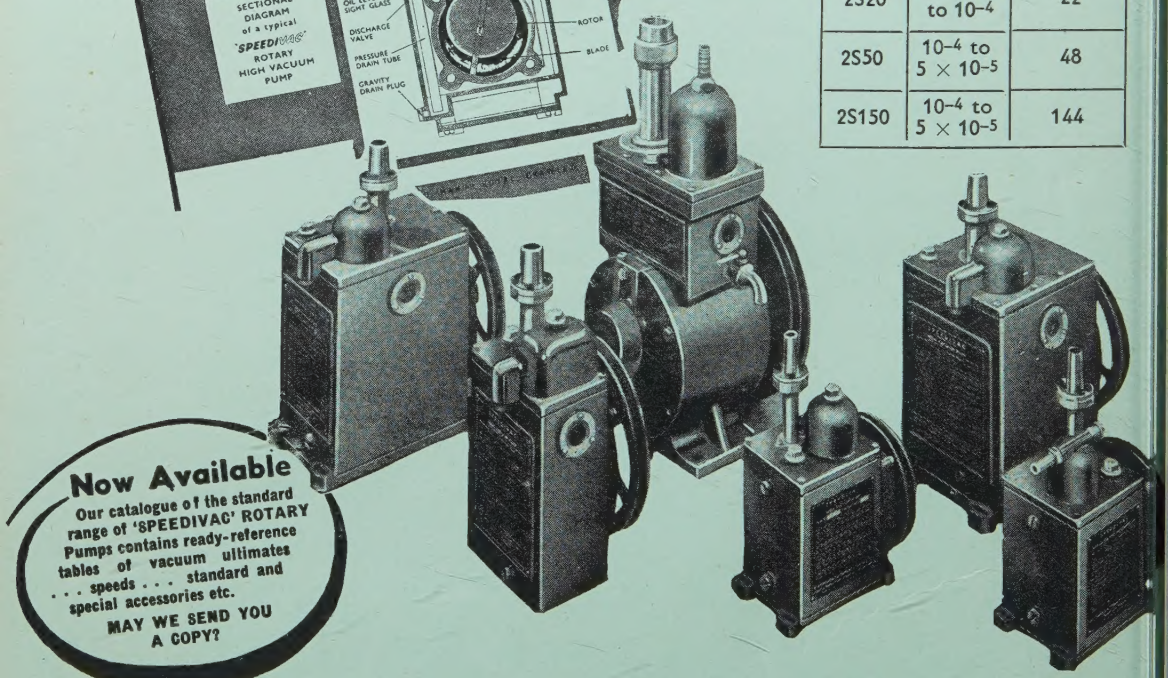
2S50	10^{-4} to 5×10^{-5}	48
2S150	10^{-4} to 5×10^{-5}	144



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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953) and the Supplement published with the Index to Volume 56 (1953). Reprints of the List of Journals (1953) and the Supplement (1953) can be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

A.T.A. Ricerche	*A.T.A. Ricerche.* [*Giornale et Atti della Associazione Tecnica Automobile.*] Via Santa Teresa 23, Turin.
Bull. Engng Res. Inst. Kyoto Univ.	*Bulletin of the Engineering Research Institute of Kyoto University.* Kyoto.
Convention Record of the Inst. Radio Engrs	*Convention Record of the Institute of Radio Engineers.* 1 East 79th Street, New York 21, N.Y.
Prace P.I.T.	*Prace Państwowego Instytutu Telekomunikacyjnego.* (Formerly *Prace Badawcze Instytutu Telekomunikacyjnego* [*Prace Badawcze P.I.T.*].) Ratuszowa 11, Warsaw.
Rep. Elect. Commun. Lab. [*Tokyo*]	*Reports of the Electrical Communication Laboratory.* Nippon Telegraph and Telephone Public Corporation. 1551 Kichijoji Musashino-shi, Tokyo.
Rev. Assoc. Ingén. Techn. Charleroi	*Revue de l'Association des Ingénieurs Techniciens de Charleroi.* 18 Galerie de Waterloo, Ixelles-Brussels.
Rev. Soc. Roy. Belge Ingén. Industr.	*Revue de la Société Royale Belge des Ingénieurs et des Industriels.* 3 Rue Ravenstein, Brussels.
Rev. Univ. Nac. Eva Peron	*Revista. Universidad Nacional de Eva Peron.* Facultad de Ciencias Fisico-matematicas, Direccion de Publicaciones. Avenida 1, Esquina 47,—Eva Peron, Argentina.
Voprosy energetiki.	*Voprosy energetiki.* Publishing House of the Academy of Sciences of the Latvian SSSR, Riga.

Notes

Indian and Eastern Engineer	Address changed to "Bapnu Ghar," Dr. Annie Besant Road, Hornby Vellard, Bombay-18; Furnival House, 14–18 High Holborn, London, W.C.1.
Journal of the Junior Institution of Engineers	Address changed to 14 Rochester Row, Westminster, London, S.W.1.
Memoires de la Société Royale Belge des Ingénieurs et des Industriels	Incorporated in *Revue de la Société Royale Belge des Ingénieurs et des Industriels* [*Rev. Soc. Roy. Belge Ingén. Industr.*] as from *January*, 1954.
Prace Badawcze Państwowego Instytutu Telekomunikacyjnego	Title changed to *Prace Państwowego Instytutu Telekomunikacyjnego* [*Prace P.I.T.*] as from Volume 2, Number 3. For address see under that entry above.
Proceedings of the Institution of Electrical Engineers	Commencing in *January*, 1955, the *Proceedings* will be divided into three parts only: *Part A, Power Engineering; Part B, Radio and Electronic Engineering; Part C, Monographs.*
Revue de la Faculté des Sciences de l'Université d'Istanbul	Commencing in *January*, 1954, this journal has been divided into three parts: *Série A, Mathématiques; Série B, Sciences naturelles; Série C, Astronomie-Physique-Chimie.*
Zeitschrift für physikalische Chemie	The journal formerly listed as *Z. phys. Chem.* will now appear as *Z. phys. Chem.* [*Leipzig*].

Errata

Abstr. 9088 (1952), line 3: *for* **20** *read* **23.**

Abstr. 786 (1954), lines 2 and 3: *for* G. R. REYNOLDS *read* G. T. REYNOLDS.

Abstr. 5934 (1954), line 10: *for* 0·11 *read* 0·011.

line 11: *for* 0·60 *and* 0·11 *read* 0·060 *and* 0·011 *respectively.*

line 12: *for* 0·04 *read* 0·004.

Abstr. 7728 (1954), line 2: *for* Y. C. L. YUAN *read* L. C. L. YUAN.

MATHEMATICS 51

512.394

7985. On roots of transcendental equations. A. F. KAY. Letter in *J. appl. Phys.*, **25,** 811 (*June*, 1954).

A well-known method is outlined for estimating the magnitude of the least root of a polynomial or transcendental (power series) equation. The aim is to bring the information to the attention of physicists. Upper and lower bounds are also given for the root, and nine references give further information.

L. S. GODDARD

513.76

7986. "Gum-transformations"—mechanical model for visualizing conformal transformation and its applications. K. SUETAKE. *J. Inst. Elect. Commun. Engrs Japan*, **35,** 573–5 (*Dec.*, 1952) *In Japanese.*

The figure to be transformed is drawn on a sheet of elastic material such as rubber. By deforming this in accordance with the particular functional form in question, the desired figure can easily be obtained. The principle is applicable in general to functions of a complex variable which are to be transformed conformally. A simple mechanical explainer for conformal transformation is described which consists of a sheet of paper folded like a ruff. This affords a simple approximate explanation of the conformal transformation of elementary functions such as $1/Z$, $\sin Z$, $\tan Z$, Jacobian elliptic functions, etc. A. WILKINSON

517.941.9

7987. Generalization of Schrödinger's factorization method. W. LASKAR. *C.R. Acad. Sci.* [*Paris*] **238,** 772–4 (*Feb.* 15, 1954) *In French.*

For Schrödinger's method see *Proc. Roy. Irish Acad.*, **46,** 9 (1940); **46,** 143 (1941); **47,** 53 (1941). It relates to the factorization of equations of the form $Py = \lambda y$, where $P = d^2/dx^2 + r(x, m)$. An exposition was given recently by Infeld and Hull [Abstr. 5973 (1951)]. The method is now generalized by using some theorems on the roots of Hermitian operators in a Hilbert space. These have been given by Professor Julia in his course at the Sorbonne. L. S. GODDARD

518.4

7988. Graphical method for the solution of spherical triangles. R. CAZENAVE. *Cahiers de Phys., No.* 48, 67–9 (*March*, 1954) *In French.*

In many problems, an approximate method for the solution of spherical triangles is sufficient. A rapid graphical method is described and applied to the cases of a triangle with 3 given sides and with 2 sides and included angle given. R. W. FISH

518.5

7989. Optimal accuracy in computers with sliding binary point. K. SAMELSON AND F. L. BAUER. *Z. angew. Math. Phys.*, **4,** *No.* 4, 312–16 (1953) *In German.*

In automatic computing with sliding binary point, the numbers are represented in semilogarithmic fashion so that the machine can fix the binary point in such a way that $1 >$ mantissa $\geqslant \frac{1}{2}$. The condition relating to the lower limit must be abandoned to prevent rounding-off errors from being concealed; the binary point must be set initially by a conversion routine, and subsequently by the machine which thus estimates the accuracy of the computation. The basic arithmetic operations and binary-decimal conversion routines are discussed from this viewpoint. T. J. REY

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.612

7990. A new model of a photoelectric stellar photometer with direct-intensity recording. P. GUERIN AND M. LAFFINEUR. *C.R. Acad. Sci.* [*Paris*] **238,** 1692–4 (*April* 26, 1954) *In French.*

Details are given of a compensated spectrophotometer employing 2 photomultipliers which feed separate linear amplifiers, the electrical bridge circuit being arranged to annul any fluctuation of total brightness during a recording of the spectral distribution of a stellar source. The complete record from 3200 Å to 6000 Å takes 20 min, and an example is reproduced.

D. R. BARBER

523.11 : 523.161 : 523.2

7991. Origin of the protoplanetary cloud according to the cosmogonical theory of O. Yu. Shmidt. V. V. RADZIEVSKIĬ. *Dokl. Akad. Nauk SSSR*, **90,** *No.* 4, 517–20 (1953) *In Russian.*

See Abstr. 7725 (1950). Discusses Shmidt's capture hypothesis [*Four lectures on the theory of the origin of the earth*, published by *Akad. Nauk SSSR*, (1949, 1950)] and, in particular, the mechanism of the capture of cosmic dust by the sun, based on the increment of the effective (reduced) mass of the latter. This increment is assumed to be due to the increasing screening of solar radiation by particles which are being captured in any manner, while, due to diffraction, the long-wave radiation re-emitted by these particles does not exert any pressure. It is shown that the capture of dust by the stars, due to their natural cooling, is not a hypothesis, but, unlike other mechanisms of capture, is a regular property of every star during a certain stage of its life. It is concluded that stellar evolution involves an "exchange of matter," viz. the residue of the star's own dust matter (having no essential momentum) is ejected, while the dust from the interstellar space is captured, and its momentum can be sufficient to promote the formation of planets. The origin of the protoplanetary juxta-solar swarm is explained tentatively. F. LACHMAN

523.161

7992. Quantitative characteristics of the turbulence of the interstellar gas. S. A. KAPLAN. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 5, 801–4 (1953) *In Russian.*

Discusses the fundamental scale of turbulence (i.e. the maximum size of eddies for which the turbulence can be looked upon as being locally isotropic), which is evaluated at $\simeq$ 90 parsec, the velocity of the eddies being $\simeq 4{\cdot}3$ km/sec, and the mean period of a significant velocity change being $\simeq 2\times10^7$ years. It is assumed that the fundamental source of energy of the turbulent motion of the gas clouds is to be looked for in the fluctuations of the pressure of radiation of the hot stars (type O and B), and the value of ε (energy of turbulent motion, dissipated per second in 1 g of interstellar gas) obtained on this basis agrees with results obtained by other methods. F. LACHMAN

523.161

7993. Some properties of cosmic dust. V. I. KRASOVSKIĬ. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 5, 805–8 (1953) *In Russian.*

Discusses the charges and other properties of dust particles and concludes that (1) the effective section of the charged cosmic-dust particles for their collisions with the clouds of ionized gas is greater than their gas-kinetic (geometrical) section, (2) condensation of the interstellar ionized gas near the stars on positively charged particles is little probable, (3) condensation of the interstellar ionized gas occurs more readily on neutral and negatively charged particles, i.e. in regions of the cosmic space characterized by a small density of ultraviolet radiation, and (4) condensation of neutral interstellar gas is possible on both positive and negative particles. Collisions of particles among themselves and possibilities of change of charge are also discussed. F. LACHMAN

523.161

7994. Dust and gas in interstellar space. A. I. LEBEDINSKIĬ. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 3, 507–10 (1953) *In Russian.*

Emphasizes the part played by the heat of chemical reaction (causing the "local rise of temperature") generated when atoms of interstellar gas are adsorbed by dust particles. The main cause of these local rises of temperature is the formation of H_2 from H atoms. The total number of molecules of the dust particle evaporating when energy ε is liberated, is calculated to be $\simeq 0{\cdot}026\,\varepsilon/U$, where U is the average heat of evaporation of 1 molecule. Values of U and of T^* (absolute temperature at which the density of saturating vapours is 1 molecule/cm^3) are tabulated for H_2 and 8 simple compounds. If the temperature of the cosmic dust is $\simeq 10°$K, H_2 cannot solidify on dust particles. For the range 10–30°K, the value of U is $\simeq 0{\cdot}1$–$0{\cdot}15$ eV; owing, however, to the local rises of temperature, there remain in these particles only molecules with $U \simeq 0{\cdot}5$ eV. With the exception of H_2, the evaporated molecules undergo photodissociation. H_2 is dissociated only by the same emission that ionizes H. The condition of growth of the dust particles in the nebulae is formulated as $\xi < \xi_0 = 1{\cdot}5\,x_0$, where ξ is the (fractional) number of H and H^+, while x_0 is the (fractional) total number of atoms of elements condensable on the dust particles. The relationships between ξ and Q (number of quanta of ultraviolet emission capable of dissociating H_2) is discussed. Two fundamental types of nebulae follow from this discussion: (1) the emission-type nebulae, consisting of atomic and ionized H, without dust, and (2) dark nebulae, with dust, consisting mainly of H_2. F. LACHMAN

523.161

7995. The state of motion of H II regions of the interstellar gas. L. BIERMANN AND A. SCHLÜTER. *Z. Naturforsch.*, **9a**, 463–9 (*May*, 1954) *In German.*

A discussion based partly on a paper, *On the influence of radiation, ionization and magnetic fields on the dynamics of the interstellar medium*, presented to the symposium on "Gas dynamics of the interstellar clouds" (Cambridge, July, 1953). Existing data on the temperature-pressure relationship in the interstellar H I, and H II clouds, and in the intervening H II zones, are reviewed; and it is pointed out that, for the well-observed dense H II regions, expansion is incipient with a velocity of the order of that of sound. This expansion process is regarded as a potent source of kinetic energy for the interstellar gas. D. R. BARBER

523.165

7996. Galactic radio sources of large angular diameter. R. H. BROWN, H. P. PALMER AND A. R. THOMPSON. Letter in *Nature* [*London*] **173**, 945–6 (*May* 15, 1954).

The apparent diameters of five of the more intense sources which show a concentration to the galactic plane have been examined on 1·89 m with a variable interferometer consisting of a fixed 218 ft paraboloid and a small mobile aerial of 35 m^2 area, the intense Cassiopeia source being used for calibration. Two of the sources had equivalent strip widths of about $1\frac{1}{2}°$, the other three between $1\frac{1}{2}°$ and 3°. One of the sources of determinate diameter coincides in position and size with a faint nebulosity observed in red light by Minkowski on plates of the National Geographic Survey (48 in. Schmidt). Combining these observations with previous ones, a total of nine sources of angular diameters about 1° and apparent surface temperatures of a few hundred degrees K have been found close to the galactic plane, three of which have been identified with faint filamentous galactic nebulosities. M. W. OVENDEN

523.165

7997. Probable observation of the galactic nucleus at 400 Mc/s. R. X. MCGEE AND J. G. BOLTON. *Nature* [*London*] **173**, 985–7 (*May* 22, 1954).

A parabolic reflector of aperture diameter 80 ft, focal length 40 ft and beam-width 2° was used to survey the central section of the Milky Way from −17° to −49° in declination and 15 hr to 20 hr in right ascension. The direction of the beam is altered by tilting the dipole mast in the meridian plane, calibration observations being made on the sun and the radio star Centaurus-A. The contours of equivalent aerial temperatures are shown in galactic co-ordinates. A strong concentration, with several maxima, is indicated along the line of galactic latitude −1°, with about 5° along galactic longitude between profile half-power points. The brightest maximum is at galactic longitude 327·9° and galactic latitude −1·0°, ±0·2° in each co-ordinate. An intense source con-

tributing an aerial temperature of about 150°K is indicated, with an angular width less than the beam-width used. The mean position of the galactic centre from optical data and observations with wide-beam radio aerials is given as 328°, −2°. M. W. OVENDEN

523.165 : 523.161

7998. The possibility of observing monochromatic radio-emission of interstellar molecules. I. S. SHKLOVSKIĬ. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 1, 25–8 (1953) *In Russian.*

A good agreement is found for the $\Delta\nu(J)$ values of OH between experimental data and those calculated by means of the van Vleck formula [*Phys. Rev.*, **33**, 467 (1929)]. A table gives the calculated values for the resolution of the Λ-type doublets for the deepest levels of the OH, CH and SiH molecules: the *J*-values are $1\frac{1}{2}$, $\frac{1}{2}$, and $\frac{1}{2}$, and the λ-values, 18·3, 9·45 and 12·5 cm (or $\Delta\nu$, 1640, 3180 and 2395 Mc/s), respectively. The probable intensities of these radio lines are discussed. It seems that the optical thickness of the Galaxy for the CH and OH lines would be only by ∼ one order of magnitude lower than that for the H radio line $\lambda = 21$ cm. Monochromatic radio emission from interstellar hydride molecules can be observed on earth without atmospheric interference. F. LACHMAN

523.2 : 523.11

7999. Cosmogony of the planetary system and the evolution of the sun. B. YU. LEVIN. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 3, 471–4 (1953) *In Russian.*

The relationship $T \propto M^{\frac{1}{3}}$ is derived, where T is the temperature of particles in equilibrium with solar radiation, and M, solar mass. Assuming the space to be transparent, the formula $T = (277/\sqrt{R})\, M^{\frac{1}{3}}$ gives the temperature of particles that were at the same distance from the sun (solar mass M) at which was simultaneously the planet which now (when $M = 1$) is at the distance R from the sun. It is shown that, if the planets were formed when the evolution of the sun proceeded along the upper portion of the main sequence, the solar mass ought to have been $< 2\frac{1}{2}$, i.e. the sun was a star of the spectral class not earlier than *A*. It follows from the size of the orbit of the planet Mercury that, even if the planets were formed during the pre-star stage, the sun, entering upon the upper portion of the main sequence, would have had a mass $< 2\frac{1}{2}$ times its present mass. Fesenkov's hypothesis [*Trudy pervogo soveshchaniya po kosmogonii, izd. Akad. Nauk SSSR* (1951)] of solar evolution along the upper portion of the main sequence is discussed, and two alternative conclusions are shown to be feasible: (1) if the sun was formed as a star of the spectral class A (or a later one), its mass being $< 2\frac{1}{2}$ times its present mass, the protoplanetary cloud could have been formed either during an unexplainable preceding stage of development (by capture or other method), or during the star stage (following the entry into the main sequence) and then only by capture; (2) if the sun was formed as a highly luminous star of great mass, the protoplanetary cloud was formed (only by capture) later, when the solar mass decreased to $< 2\frac{1}{2}$ times its present mass. F. LACHMAN

523.72

8000. The distribution of temperature in the solar atmosphere in non-grey radiative equilibrium. K.-H. BÖHM. *Z. Astrophys.*, **34**, *No.* 3, 182–208 (1954) *In German.*

Various iterative solutions of the equation of transfer in a non-grey atmosphere are considered and an improved version of Unsöld's method of flux-iteration is proposed. An application of the method leads to a temperature distribution which agrees with the empirical model of E. Böhm-Vitense in the range of optical depth $0{\cdot}05 < \tau_{5010\text{A}} < 1{\cdot}5$. The observed departures in the highest layers imply that some of the assumptions employed are no longer valid. A. BEER

523.72

8001. Solar radio asymmetry at 4-metres wavelength. J. S. HEY AND V. A. HUGHES. Letter in *Nature* [*London*] **173**, 771 (*April* 24, 1954).

The failure of Dodson, *et al.* [Abstr. 1974 (1954)] to detect on 1·5 m a more pronounced correlation of radio bursts with flares on the eastern solar hemisphere than with flares on the western hemisphere, as observed by Hey *et al.* [Abstr. 3687 (1950)] on 4·1 m, is attributed to the differences in absorption co-efficient and refractive index at the two wavelengths of the corpuscular streams emitted by the sun. Observations of the asymmetry from 1946 to 1951 suggest that corpuscular streams associated with recurrent *M*-type magnetic storms may be more important in producing absorption than the sporadic streams emitted by solar flares. M. W. OVENDEN

523.73

8002. A variation with time of the law of solar rotation. U. BECKER. *Z. Astrophys.*, **34**, *No.* 3, 229–36 (1954) *In German.*

A statistical study of the motions in heliographic longitude of sunspot groups, covering the period 1900–1930, indicates characteristic deviations from the law of rotation as stated by the Greenwich observers ($\xi = 14{\cdot}37° - 2{\cdot}60 \sin^2 b$, where ξ is the amount of the daily rotation and b the heliographic latitude). It is found that at the beginning of the 11-year cycle the rotation (in high latitudes) appears to be too fast; and at the end of the cycle it is (in lower latitudes) too slow, when referred to the middle of the cycle. Comparisons with older discussions confirm this result. A. BEER

523.74

8003. Centre-to-limb darkening of the sun between 3190 Å and 8638 Å. R. PEYTURAUX. *C.R. Acad. Sci.* [*Paris*] **238**, 1867–8 (*May* 10, 1954) *In French.*

A continuation of previous work [see Abstr. 7463 (1951) and 5277 (1953)]. The same technique has been used in u.v. and visible regions, a 7-stage photomultiplier replacing the PbS infrared detector. The u.v. measures exhibit the Balmer discontinuity below 4000 Å. A set of repeat measures in the i.r., with the PbS cell, to overlap the visual range agrees well with previous results. D. R. BARBER

523.74 : 550.384

8004. Relationship between appearance of the yellow coronal line and geomagnetic activity. J.-F. DENISSE AND P. SIMON. *C.R. Acad. Sci.* [*Paris*] **238**, 1775–8 (*May* 3, 1954) *In French.*

Observations of the yellow coronal line made at Climax and Sacramento Peak, U.S.A., over the period, 1946–1950, indicate that the emission occurs over

centres of solar activity whose central meridian passage is accompanied statistically by enhanced geomagnetic disturbance [see also Abstr. 4122 (1954)].

D. R. BARBER

523.75 : 532.51 : 538

8005. Magneto-hydrodynamic motions in solar protuberances. A. B. SEVERNYĬ. *Dokl. Akad. Nauk SSSR*, **91,** *No.* 5, 1051–4 (1953) *In Russian.*

A mathematical analysis of the motion of nodes and streams in protuberances, based on the fundamental equations of magneto-hydrodynamics for small-scale motions in the neighbourhood of the hydrostatic equilibrium of plasma in the external magnetic field H_0 (along the z axis) and the gravitational field g_0. This procedure is claimed to take into account the following factors disregarded by other authors: gas compressibility, gravitation and the induced field.

F. LACHMAN

523.752

8006. A study of spatial movement in solar prominences. D. E. BILLINGS AND J.-C. PECKER. *C.R. Acad. Sci.* [*Paris*] **238,** 1690–2 (*April* 26, 1954) *In French.*

Simultaneous measurements of the positions of prominence structures seen projected against the sky-background, and referred to co-ordinates in the sky-plane, and along the line-of-sight, permit a direct comparison of the results with those computed on the basis of dynamical theory.

D. R. BARBER

523.755

8007. Inhomogeneity of the solar corona. V. A. KRAT. *Dokl. Akad. Nauk SSSR*, **91,** *No.* 4, 757–8 (1953) *In Russian.*

Describes the spectrum of a very feeble protuberance observed during the 1945 total solar eclipse. Except the H and K lines of ionized Ca, all other spectral lines of this protuberance are much weaker than those of the corona; particularly weak are the lines of H. The distribution of the H atoms in energy levels differs widely from the Boltzmann distribution. The numbers of atoms of metals, and of H, along the line of sight in the protuberance are $\sim 1/100$, and $\sim 1/200$, those in the chromosphere, respectively. Hence the density of matter in the protuberance is probably $\sim 1/10^2$ that in the upper chromosphere layers (i.e. $\simeq 10^9$ particles/cm^3). The equivalent widths of the H and K lines in the corona spectrum, evaluated by a previously described method [*Izv. GAO*, *No.* 142 (1949)] are tabulated. A discrepancy of ~ 2 orders of magnitude is found to exist between the equivalent widths for the corona and protuberance. It is concluded that the temperature of the corona filaments which generate the H and K lines is by 2 orders of magnitude lower than the usually accepted mean temperature of the corona.

F. LACHMAN

523.76

8008. On the distribution with depth of temperature and pressure in the solar atmosphere. E. BÖHM-VITENSE. *Z. Astrophys.*, **34,** *No.* 3, 209–28 (1954) *In German.*

An empirical model of the solar atmosphere is derived from a re-examination of the temperature distribution deduced by Barbier [*Z. Astrophys.* **7,** 115 (1944)] from the limb-darkening curves in the continuous spectrum. The temperatures obtained are by about 100° lower than that given by de Jager in 1948. The surface temperature is derived from the centre-limb variations in the strengths of the strong Fraunhofer lines of H and Fe and comes to 3800° (a result which should be treated with reserve in view of possible deviations from thermodynamic equilibrium in the layers responsible for the formation of the line centres). The temperature distribution for the optical depth $\tau > 0{\cdot}1$ agrees well with that calculated theoretically.

A. BEER

523.76

8009. Determination of a solar model from a study of the absorption lines of vanadium. H. VAN REGEMORTER. *C.R. Acad. Sci.* [*Paris*] **238,** 1778–9 (*May* 3, 1954) *In French.*

Using equivalent-width data for the weak absorption lines of neutral V, a solar model has been constructed which resembles closely one based on the limb-darkening found from the solar continuum. An excitation temperature of ~ 5000°K is found for the V lines in the region, 4000 Å–5000 Å.

D. R. BARBER

523.77

8010. Studies of non-coherent scattering in Fraunhofer lines. II. D. LABS. *Z. Astrophys.*, **34,** *No.* 3, 173–81 (1954) *In German.*

Further development of the results derived in Pt I [Abstr. 1401 (1952)]. The behaviour of Fraunhofer lines formed by non-coherent scattering is investigated qualitatively, using drastic simplifying assumptions. In contrast with earlier work a Planck function of the form $B_\nu = B_0\,(1 + \beta_0\tau - C\,e^{-\gamma\tau})$ is assumed, the parameters β_0 and γ being permitted to vary over a wide range. The results are shown graphically.

A. BEER

523.77

8011. Polarization measurements in Fraunhofer lines of the solar spectrum. F. W. JÄGER. *Z. Astrophys.*, **34,** *No.* 4, 237–58 (1954) *In German.*

Photographic photometry of the resonance lines of Ca (4227 Å), Na (D_1, D_2) and Mg (b_1, b_2) in spectra of the N- and E-limbs and centre of the sun obtained with the Gottingen tower-telescope and polarization-spectrograph reveals predicted differences in the degree of polarization based on the theory of resonance-fluorescence for these lines. Agreement of experimental and theoretical values for the polarization is satisfactory. The results for the 5 lines, based on observations in the 3 positions mentioned, are tabulated. The Ca line has the largest polarization, viz. $5{\cdot}1 \pm 0{\cdot}9\%$ at the N-limb, and shows also the greatest difference between N- and E-limbs, viz. $3{\cdot}7\%$. Confirmation is obtained of the essential rôle of coherent scattering in the centre of a resonance absorption line.

D. R. BARBER

523.821

8012. The law of centre-to-limb darkening of a stellar disk, and its application to Algol. Classification of Algol. D. CHALONGE, L. DIVAN AND G. DE STROBEL. *C.R. Acad. Sci.* [*Paris*] **238,** 1868–70 (*May* 10, 1954) *In French.*

Given the temperature of a stellar surface radiating as a grey body, it is possible to evaluate the variation of its brightness along a radius vector at any chosen

wavelength. The method has been applied to the eclipsing binary, Algol, assuming a surface temperature of 8700°K for the bright component; and a curve of variation of the Balmer discontinuity, D, at 3754 Å as a function of phase of the primary eclipse has been constructed. The value of D is 0·33, in good agreement with observation (Barbier and Chalonge, 1938). The spectral class of the bright component based on the Chalonge–Divan (λ_1, D) scale is B 7 V. D. R. BARBER

523.852.2

8013. Study of the stability of certain nebulae. R. KLEIN. *Ann. Astrophys.* **17,** *No.* 1, 1–5 (1954) *In French.*

It is supposed that an O- or B-type star is surrounded by a nebula consisting of an interior region of completely ionized H and an outer region of neutral H, the two regions being separated by a moving surface of discontinuity S. The nebula is shown to be unstable with respect to harmonic fluctuations of density in S. R. A. NEWING

523.852.32

8014. Why must the distances of the spiral nebulae be about twice as great as had been fixed up-to-now? P. TEN BRUGGENCATE. *Naturwissenschaften,* **41,** *No.* 8, 173–8 (1954) *In German.*

Recent researches on the classical (δ-Cephei) variables in spiral nebulae (Population I stars), and of the Cepheid, and short-period variables in globular clusters (Population II stars), have shown that the previous assumption of a single mass-luminosity relationship to cover both cases is no longer tenable. Two separate plots of the magnitude-period curve are involved which lead to a correction of −1·5 mag. for Population I stars. Thus it follows that all distances derived from observation of this group of stars, e.g. in the spiral nebulae, will be nearly doubled; whilst no correction is required to distances derived by the aid of Population II stars. D. R. BARBER

523.855

8015. On the masses of double galaxies. E. HOLMBERG. *K. Fysiogr. Sällsk. Lund, Förhandl.,* **24,** *No.* 11, 20 *pp.* (1954).

A theoretical analysis is made of the relation between differential radial velocity and relative orbital motion of the components of double systems. A study of the projection effects involved leads to a determination of the regression curve giving the mean square of differential radial velocity as a function of the separation, and of the mean mass, of the components. As an illustration, the theory is first applied to binary stars. The analysis of double galaxies results in mean values of mass and mass-luminosity ratio that are in satisfactory agreement with previous results. A.

PHYSICS 53

53

8016. Researches on the method and fundamentals of physics. I. On the operational definitions of physical quantities. M. AGENO. *R.C. Ist. Super. Sanità,* **16,** *Pt I–II–III,* 5–13 (1953) *In Italian.*

The author maintains that the operational definition, by which the physical concept is linked directly with the empirical data on which it is based, is not entirely satisfactory, because the expression chosen for the concept depends on an imperfect instrument, the language. S. WEINTROUB

53

8017. Researches on the method and fundamentals of physics. II. On the relations between physics and geometry. M. AGENO. *R.C. Ist. Super. Sanità,* **16,** *Pt I–II–III,* 14–20 (1953) *In Italian.*

It is stressed that the operational definition of the physical concept of length presupposes an intuitive geometrical conception of a straight line and a point, and that the only satisfactory way is to avoid the use of elementary geometrical concepts. The workshop test plane, which is made by grinding one such plane against another, can be used as the basic physical plane and which therefore is defined independently of geometrical concepts and the laws of propagation of light. The problem of thus making physics, in its fundamentals, independent of geometry, is briefly discussed. S. WEINTROUB

53.081.1 : 537.3

8018. A note on the new definition of the ampere. R. GANS. *Univ. Nac. Tucumán Publ. No.* 641 (*Inst. Fis. Publ. No.* 31) 5–10 (1952) *In Spanish.*

It is pointed out that the electrostatic interaction between the two conductors used in the definition may not be negligible: the definition should be completed by stating that the conductors must be of infinite conductivity. L. PINCHERLE

53.088 : 512

8019. Establishment of an algebra of physically observable functions by means of convolution [Faltung] operations. II. Fourier-transformation of power series and multipole series. Connection with the Laplace and Mellin transformation. An extension of the theory of functions. R. HOSEMANN AND S. N. BAGCHI. *Z. Phys.,* **137,** *No.* 1, 1–30 (1954) *In German.*

For Pt I, see Abstr. 1007 (1954). In classical function theory, where we are concerned with the special case $\delta t = \delta v = 0$, the Laplace and Mellin transformations have particular advantages over the Fourier transformation, but this no longer holds for $\delta t \to 0$, $\delta v \to 0$, where the three transformations are shown to be equivalent. For $\delta t \to 0$, $\delta v \to 0$, instead of equations between functions g, G, equations between function complexes g, G, are dealt with, for which an interchange of the g, G functions of a complex within the region $\delta t \to 0$, $\delta v \to 0$ is not observable. In particular the usual awkwardness of the Fourier transformation is removed entirely. Also, function theory can be extended to include contour integration. Various examples of the application of the extended theory and of the usefulness of the new algebra are dealt with in detail. These include the logarithm, the transformation of power series and multipole summations and various other examples which are given in the 7 appendices. S. WEINTROUB

FUNDAMENTALS 530.1

530.12

8020. Critical examination of the demonstrative value of optical experiments concerning kinematics. M. GALLI. *Atti Fond. Ronchi*, **9**, 23–40 (*Jan.–Feb.*, 1954) *In Italian.*

A discussion of the Michelson–Morley, Kennedy and Ives–Stillwell experiments in relation to the deductive and inductive treatments of the Lorentz transformations. R. A. NEWING

530.12

8021. An axiomatic criticism of unified field theories. I. C. W. KILMISTER AND G. STEPHENSON. *Nuovo Cimento Suppl.*, **11**, *No.* 1, 91–105 (1954).

The concepts of theory-languages and of order [Abstr. 4147 (1954)] are used as a basis in formulating a sequence of eight axioms concerning the permissible nature of theories attempting to unify the two macroscopic fields. Dimensionality is restricted to 4 at an early stage in the investigation. Theories which are not merely formal unifications of the gravitational and electromagnetic fields are defined to be weakly or strongly unified according as the separation into the two fields is or is not invariant under the allowed transformation group.

R. A. NEWING

530.12

8022. An axiomatic criticism of unified field theories. II. C. W. KILMISTER AND G. STEPHENSON. *Nuovo Cimento Suppl.*, **11**, *No.* 1, 118–40 (1954).

In a comprehensive review both Riemannian and non-Riemannian theories are considered and evaluated in terms of the axioms of Pt I. No theory is found to be completely satisfactory and it is suggested that a formal unification may be all that is possible at the macroscopic level. R. A. NEWING

530.12

8023. Current and charge in Einstein's unified theory. S. MAVRIDÈS. *C.R. Acad. Sci.* [*Paris*] **238**, 1643–4 (*April* 21, 1954) *In French.*

Continuing previous work it is shown that corresponding to the electrostatic field finite at the origin, the field equations give a charge distribution in agreement with Born–Infeld electrodynamics. The electric field is defined in terms of ϕ_{14} and not ϕ_{23}.

R. A. NEWING

530.12

8024. General relativistic variational principle for perfect fluids. A. H. TAUB. *Phys. Rev.*, **94**, 1468–70 (*June* 15, 1954).

The field equations for the gravitational field of a perfect compressible fluid and the equations of motion of the fluid in its own gravitational field are derived from a single variational principle in which the variations of the various field quantities are restricted so that mass is conserved. A.

530.12

8025. Theory of elementary particles in general relativity. M. M. HATALKAR. *Phys. Rev.*, **94**, 1472–5 (*June* 15, 1954).

The matrices of elementary particles are generalized to general co-ordinates, and a new covariant displacement operator is defined, in order to generalize the theory of elementary particles to general relativity, and obtain general commutation rules. The elementary particle is considered as a singularity, with spin-structure of a gravitational field which gives Riemannian structure to the space-time. It is shown that the transformation properties of the space-time are determined not only by the affine structure due to the gravitational field but also by the spin-structure of the particle singularity. A.

530.12

8026. The equations of motion of charged test particles in general relativity. D. M. CHASE. *Phys. Rev.*, **95**, 243–6 (*July* 1, 1954).

The Lorentz equations of motion without radiation damping are derived for charged test particles from the field equations, $R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = T_{\mu\nu}$, of ordinary general relativity. No restriction is placed on the strength of the background gravitational and electromagnetic fields. A.

530.12 : 523.112

8027. The Schwarzschild line element and the expansion of the universe. E. SCHÜCKING. *Z. Phys.*, **137**, *No.* 5, 595–603 (1954) *In German.*

The field of a mass point in the interior of a sphere embedded in an expanding space has been considered by Einstein and Straus (1945). The problem is reconsidered working in non-isotropic co-ordinates. An expression for the line element is obtained in closed form and can be transformed to the Schwarzschild static field. Attention is drawn to a change in time scale involved in this transformation. R. A. NEWING

530.12 : 536.79

Le Chatelier–Braun principle and relativity theory. *See Abstr.* 8247

530.145

8028. The relation between the Bethe–Salpeter equation and the Tamm–Dancoff method. W. ZIMMERMANN. *Nuovo Cimento Suppl.*, **11**, *No.* 1, 43–90 (1954) *In German.*

A general formulation of the Tamm–Dancoff method, with iterated kernel, is given, using the field operators of the interaction representation to give the equations a four-dimensional form. Starting from the Bethe–Salpeter equation, the general Feynman amplitudes are introduced. Lorentz-invariant and single-time systems of equations are given for such amplitudes. Using a graphical technique, developed in an appendix, the Bethe–Salpeter equation for equal times is developed and compared with the corresponding Tamm–Dancoff equation. P. T. MATTHEWS

530.145

8029. On the solution of the equations of field theory. G. RIDEAU. *C.R. Acad. Sci.* [*Paris*] **238**, 2057–9 (*May* 24, 1954) *In French.*

A method is indicated for the solution of the Fock equations for two interacting fields which yields directly the successive Tamm–Dancoff approximations. P. T. MATTHEWS

530.145

8030. The quantum theory of unrenormalizable wave equations. W. HEISENBERG. *Z. Naturforsch.*, **9a**, 292–303 (*April*, 1954) *In German.*

The method of quantization of non-linear wave

equations given previously [*Nachr. Akad. Wiss. Göttingen, math.-phys. Kl. IIA*, 1953, *No.* 8] is applied to a special case. The propagation and commutation functions are shown to differ from those of a linear theory only at very small distances. Their form implies a finite extension of the elementary particles, but no weakening of the causality condition at least in the region of approximate validity of the classical wave-equation. The lowest energy level for a spinor field is calculated using the Tamm–Dancoff method for the Feynman amplitudes and the same problem for a Bose field is set up. Various conservation laws and the convergence of the Tamm–Dancoff method are discussed. P. T. MATTHEWS

530.145

8031. Quantization of mass and the non-local formalism. E. MINARDI. Letter in *Nuovo Cimento*, **11**, 694–6 (*June*, 1954) *In Italian.*

The quantization is discussed on the basis of several recent papers [Abstr. 3092, 5272 (1954)]. It is found that the mass spectrum is given by the roots (in m) of $J_{k+\frac{1}{2}}(ml) = 0$, for all positive integers k. Taking $l = 2{\cdot}3\times10^{-13}$ cm, we find that, when $k = 1$, $m_1 = 0$, $m_2 = 758m_e$, $m_3 = 1305m_e$, $m_4 = 1839m_e$, $m_5 = 2365m_e$, and, when $k = 2$, $m_1 = 0$, $m_2 = 972m_e$, $m_3 = 1558m_e$, $m_4 = 2072m_e$. L. S. GODDARD

530.145

8032. The theory of quantized fields. VI. J. SCHWINGER. *Phys. Rev.*, **94**, 1362–84 (*June* 1, 1954).

For Pt V, see Abstr. 5281 (1954). Treats the effect of a time-independent external electromagnetic field upon a Dirac field by constructing the transformation function in a representation adapted to the external field. In addition to the alteration of the Green's function, the structure of the transformation function differs from that of the zero field situation by a factor which describes the energy of the modified vacuum state. A formula for the vacuum energy is obtained and expressed in a form appropriate to a localized field, in terms of the energy eigenvalues of discrete modes, and of the phase shifts associated with continuum modes. Determinantal methods are then introduced, and the class of fields is established for which a certain frequency-dependent modified determinant is an integral function of the parameter measuring the strength of the field. The properties of the determinant are investigated in the two frequency regions $|p_0| < m$ and $|p_0| > m$, with regard to the zeros of the real determinant in the former region, which are the frequencies of the discrete modes, and to the phase of the complex determinant in the latter region. In the second situation, a connection is established with a unitary matrix defined for modes of a given frequency, and the phase of the determinant is expressed in terms of the eigenphases of this matrix. Following a discussion of the asymptotic behaviour of the determinant as a function of p_0, the modified determinant is constructed in terms of the discrete mode energies and of the eigenphases. This yields a more precise version of the vacuum energy formula, in which a single divergent parameter is exhibited, for a suitable class of fields. The scattering description is introduced by an evaluation of the Green's function, for a sufficiently large time interval, in terms of the discrete modes, and of linear combinations of free particle modes expressed by a unitary matrix which is an extension of that referring to modes of a single frequency. Transition probabilities are derived and summarized in a generating function that serves to evaluate occupation number expectation values for the final state, upon which is based the definition of differential and total scattering cross-sections. A discussion is presented of various symmetry operations and the resulting properties of cross-sections. Then, a determinantal formula for the individual transition probabilities is used to examine the probability for the persistence of a state, in its dependence upon occupation numbers. An incidental result of this analysis is a qualitative upper limit to total cross-sections in relation to the character of the angular distribution. A section is devoted to the properties of eigenphases, including the demonstration of equivalence between phase shifts and eigenphases, and the discussion of alternative procedures for their evaluation in terms of quantities exhibited as convergent power series in the potential. Finally, the determinantal asymptotic behaviour is used to obtain a high-energy approximation to the eigenphases for an isotropic scalar potential. The resulting high energy, small angle, form of the scattering cross-section is discussed in the extreme quantum and classical limits. An alternative derivation of the high-energy scattering formula is provided in terms of an approximate construction of the Green's function. A.

530.145

8033. Investigation of a logical quantum dynamics of electrons. II. S. C. KAR. *Bull. Calcutta Math. Soc.*, **45**, 133–71 (*Dec.*, 1953) *In German.*

The theory of a previous paper [Abstr. 3862 (1953)] is applied in detail to the important problem of the electron in atomic fields. The following cases are considered: (1) the electron in a constant electric field, (2) in a constant magnetic field, (3) the field-free electron. The path equations are derived and the energies of the various states are calculated. The latter are compared with those given by Dirac's formula. L. S. GODDARD

530.145

8034. The wave equations of quantum electrodynamics. E. FREESE. *Acta phys. Austriaca*, **8**, *No.* 3, 289–308 (1954) *In German.*

The author's formalism [Abstr. 4185 (1954)] is illustrated by considering the following cases: interaction of free and bound electrons with the radiation field in an external field, calculation of ground and excited states and of decay and transition probabilities; positronium; radiation by a moving electron.

G. FIELD

530.145

8035. Invariant delta functions in the sense of distributions. T. TAKAHASHI. *Progr. theor. Phys.*, **11**, 1–10 (*Jan.*, 1954).

Invariant δ-functions are most adequately interpreted in the sense of distributions of L. Schwartz. They are expressed as the sum of proper distributions and mass-dependent point functions. First terms are interpreted as the logarithmic or finite parts of the

divergent integrals corresponding to the inverse square of the four-dimensional distance. Point function term of $\Delta^{(1)}$ exhibits logarithmic singularities on the surface of the light cone, defining a finite value as a distribution. A.

530.145

8036. Some applications of the mass operator in quantum electrodynamics. R. G. NEWTON. *Phys. Rev.*, **94,** 1773–89 (*June* 15, 1954).

The one-photon mass operator is calculated explicitly up to the second order in the applied field, once for the purpose of taking matrix elements between states that satisfy the complete Dirac equation, and once for free-electron states. The former is manifestly gauge-invariant. The part linear in the applied field is also calculated for matrix elements, only one side of which satisfies the Dirac equation; it is seen, in application, to cancel precisely the non-gauge invariant part (for free electrons) of the second-order mass operator. A systematic procedure for carrying out the photon integration at the very beginning of the calculation is described and used. After the (nonperturbation) derivation of a cross-section formula in terms of the mass operator, the latter is used to rederive the integrated Klein–Nishina formula and also applied to the simple case of a constant field. The use of the mass operator technique for the calculation of inelastic cross-sections is demonstrated and it is proved that, except for virtual processes induced by the radiation field (in contrast to the static field), the low-energy limit of the bremsstrahlung cross-section is a multiple of the one for elastic scattering (to all orders). Finally, the lowest-order radiative corrections to Coulomb scattering are rederived. A.

530.145

8037. Some remarks on the mass spectrum and non-local interaction. H. GOTO. Letter in *Progr. theor. Phys.*, **10,** 698–700 (*Dec.*, 1953).

The mass spectrum with no degeneracy and non-local interaction is obtained from non-local field theory. G. E. BROWN

530.145

8038. Renormalization of wave-functions in field theory. W. ZIMMERMANN. *Nuovo Cimento Suppl.*, **11,** *No.* 1, 106–17 (1954) *In German.*

The renormalization of the meson-nucleon equation for scattering and the many-time Bethe–Salpeter equation of the two-nucleon problem is carried out. P. T. MATTHEWS

530.145

8039. Note on the second kind interaction. S. OKUBO. *Progr. theor. Phys.*, **11,** 80–94 (*Jan.*, 1954).

Examples which must not be treated by perturbation are given, and it is shown that there exist some second-kind interactions which become first-kind, if the use of perturbation is avoided. Especially pseudo-scalar theory with vector coupling after the Dyson transformation is appropriate, although it was proved only for vanishing meson mass. Finally Green functions in scalar meson theory with vector coupling are obtained exactly. A.

530.145

8040. Charged elementary particles with finite rest mass and arbitrary spin in an [external] electromagnetic field. H. DONNERT. *Z. Phys.*, **137,** *No.* 5, 649–60 (1954) *In German.*

The introduction of auxiliary fields of lower spin, found necessary by Pauli and Fierz, can be avoided by the use of Cap's modified spinor theory [Abstr. 3088–90 (1954)]. For the case of Coulomb scattering, the relativistic Rutherford formula is derived, in which the spin-dependent term is of an analogous form to the Mott term for spin $\frac{1}{2}$ particles. G. FIELD

530.145

8041. Covariant relativistic theory of the bound particle. O. COSTA DE BEAUREGARD. *C.R. Acad. Sci.* [*Paris*] **238,** 1196–8 (*March* 15, 1954) *In French.*

Application of earlier work [Abstr. 4203–4 (1954)]. R. A. NEWING

530.145

8042. Relativistic configuration space formulation of the multi-electron problem. II. M. GÜNTHER. *Phys. Rev.*, **94,** 1347–57 (*June* 1, 1954).

For Pt I, see Abstr. 1376 (1953). Deals with an adaptation of the formalism developed in Pt I to the Dirac "hole theory." This adaptation is achieved by the application of methods which are based on the (relativistic) configuration space concept and, simultaneously, on second quantization. The electrons (and positrons) are thus divided into "configurational" and "background" electrons (and holes). This separation may be believed to give appropriate means for handling bound state problems with a finite number of configurational particles. The background is then the Dirac ("physical") vacuum. A.

530.145

8043. Description of a composite particle in terms of a functional potential well. R. FINKELSTEIN, S. G. GASIOROWICZ AND P. KAUS. *Canad. J. Phys.*, **32,** 480–91 (*July*, 1954).

A covariant two-particle wave equation of the following form is investigated: $[D_1 + D_2 + gF(\psi)]\Psi = 0$ where D_k is the Dirac operator $(\gamma_\mu p_\mu - im)_k$ and $F(\psi)$ is a functional "potential well." $\Psi_{\alpha a}$ is interpreted as a probability amplitude and transforms as a spinor on both indices. ψ is the internal wave function depending only on the relative co-ordinates. This equation provides a covariant model which exhibits nonlocal interactions and can be studied by relatively simple methods. The investigation is primarily methodological. The physical model is similar to the Fermi–Yang pion and, like it, is qualitative and not based on fundamental theory. A.

530.145

8044. A new variant of equations of the meson vector theory. N. S. KALITSIN. *Zh. éksper. teor. Fiz.* **24,** *No.* 3, 293–8 (1953) *In Russian.*

Equations derived for meson vector field in a five-dimensional space are used for calculating the potential of nuclear forces. Suitable choice of constants eliminates, in the non-relativistic approximation, the singular dipole potential of the $1/r^3$ form. The final equation for the potential energy of interaction between two nucleons through a mesonic field is invariant with respect to an inversion of the

system of co-ordinates and to the interchange of the positions of the nucleons. F. LACHMAN

530.145

8045. On the choice of the "unperturbed" energy operator in the theory of the interaction of a nucleon with the pseudoscalar meson field. YU. V. NOVOZHILOV. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 5, 931–3 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-217.

Pseudoscalar coupling and charge symmetric theory are assumed. It is found that for a non-relativistic nucleon the only interactions of importance occur with mesons which have angular momenta $l = 0$ and $l = 1$. For large values of the coupling constant, mesons with $l = 0$ interact with the nucleon much less strongly than those with $l = 1$. In this case the "unperturbed" Hamiltonian is chosen to be that containing emission and absorption operators for mesons with $l = 1$. As a check on this procedure, values of the magnetic moments of the proton, $\mu_P = 2{\cdot}3\mu_0$, and neutron, $\mu_N = -1{\cdot}75\mu_0$, are obtained, which are in better agreement with experiment than the results of weak-coupling theory. G. FIELD

530.145

8046. Note on the neutral vector meson theory. R. J. GLAUBER. Letter in *Progr. theor. Phys.*, **10**, 690 (*Dec.*, 1953).

Mass renormalization in a theory [Abstr. 4163 (1954)] employing a vector field A_ν and a scalar field B is briefly discussed, especially in connection with another paper [Abstr. 2029 (1954)]. G. E. BROWN

530.145

8047. Non-perturbation approach method by Edwards. S. OKUBO. Letter in *Progr. theor. Phys.*, **10**, 692–4 (*Dec.*, 1953).

This method is applied to the interaction of scalar mesons and scalar photon fields. The functions Δ'_F and $\Gamma(p, p)$ are obtained, and mass subtraction is carried out. G. E. BROWN

530.145

8048. Fourth order calculations of meson-proton scattering in the symmetrical Ps(Ps) theory. K. NAKABAYASI, K. HASEGAWA AND I. YAMAMURA. Letter in *Progr. theor. Phys.*, **10**, 694–5 (*Dec.*, 1953).

Calculations are carried out for incident meson energies up to 180 MeV. The experimental energy-dependence is not reproduced. G. E. BROWN

530.145

8049. Fourth order phase shifts for meson-proton scattering in the symmetrical Ps(Ps) theory. K. NAKABAYASI, K. HASEGAWA AND I. YAMAMURA. Letter in *Progr. theor. Phys.*, **10**, 696–7 (*Dec.*, 1953); Erratum, **11**, 230 (*Feb.*, 1954).

Phase-shift analysis is carried out for the calculations of the preceding abstract. G. E. BROWN

530.145

8050. Nucleon-pion interaction. G. EDER. *Acta phys. Austriaca*, **8**, *No.* 3, 234–75 (1954) *In German.*

Reviews *n-p* and *p-p* scattering at all energies, pion scattering by nucleons and photoproduction of pions. G. E. BROWN

530.145

8051. The meson theory of nuclear forces. II. High energy nucleon-nucleon scattering. S. FUJII, J. IWADARE, S. OTSUKI, M. TAKETANI, S. TANI AND W. WATARI. *Progr. theor. Phys.*, **11**, 11–19 (*Jan.*, 1954).

For Pt I, see Abstr. 7963 (1952). Using the potentials derived from pseudoscalar (pseudovector) meson theory of the second and fourth order, neutron-proton and proton-proton scattering at 40 MeV and 90 MeV in the laboratory system are examined. Calculation is performed by numerical integrations. The characteristic features of high energy nucleon-nucleon scattering are fairly well explained by the pseudoscalar meson potential. A.

530.145

8052. Many-level dispersion in Fock's space. III. F. M. MEDINA NICOLAU. *Rev. Mexicana Fis.*, **3**, 43–62 (*Jan.*, 1954) *In Spanish.*

Previous results [*Rev. Mexicana Fis.*, **2**, 117, 268 (1953)] are extended to the case in which the relative angular momentum of the two interacting particles is different from zero. The formation of an intermediate compound particle of non-vanishing radius is assumed; only the case of one resonant level of this compound particle is treated. L. PINCHERLE

530.145

8053. Nucleon scattering by a potential. M. MATSUMOTO AND W. WATARI. *Progr. theor. Phys.*, **11**, 63–79 (*Jan.*, 1954).

Scattering of a nucleon by a central potential is discussed. The potential consists of a sequence of square wells. Relations between the phase shift of the partial wave and the potential shape are extensively examined for incident energy lower than 300 MeV in a laboratory system. The S, P, D, F and G partial waves are taken into account. The results are summarized in the form of graphs. A.

530.145

8054. On the contribution of the meson-meson interaction to nuclear forces. G. BONNEVAY. *C.R. Acad. Sci.* [*Paris*] **238**, 1641–3 (*April* 21, 1954) *In French.*

A direct meson-meson interaction is required for the renormalization of pseudoscalar meson theory. The effect of this on Lévy's calculation [Abstr. 38, 621 (1953)] of nuclear forces is worked out to order g^4. The result is just a constant multiple of the G_1^4 term in the Lévy potential. P. T. MATTHEWS

530.145

8055. Rearrangement collisions. B. H. BRANSDEN. Letter in *Phys. Rev.*, **94**, 726 (*May* 1, 1954).

The Born approximation satisfies the reciprocity theorem. Hence, it is meaningless to assert that approximate calculations employing the prior interaction are superior to those employing the post interaction. G. E. BROWN

530.145

8056. Covariant formulation of the Tamm–Dancoff method. S. S. SCHWEBER. Letter in *Phys. Rev.*, **94**, 1089 (*May* 15, 1954).

The treatment is illustrated by considering the two-nucleon problem in scalar meson theory. The equation of motion of the four-dimensional amplitudes (closely related to Dyson's) is set up in the lowest approximation (two nucleons with at most one meson). It is shown to be analogous to the Bethe–

Salpeter equation in the ladder approximation and is similarly renormalizable. G. FIELD

530.145

8057. A method for collision problems with a modified Coulomb potential. D. BARONCINI. Letter in *Nuovo Cimento*, **11**, 688–91 (*June*, 1954) *In Italian.*

The solution of the radial equation is expanded in a series of solutions for the Coulomb potential. One obtains then for the coefficients an integral equation whose nucleus is the transform of the non-Coulomb part of the potential (e.g. a nuclear potential) according to the Coulomb functions. It is shown how the phases of the scattered partial waves may be obtained from the solution of the integral equation.

L. PINCHERLE

530.145

8058. Meson-nucleon scattering. I. R. J. RIDDELL, JR AND B. D. FRIED. *Phys. Rev.*, **94**, 1736–48 (*June* 15, 1954).

An approximate quantum-mechanical solution of the meson-nucleon scattering problem for intermediate values of the coupling constant is presented. The particular case treated here is that of charged scalar mesons interacting with a static nucleon. In finding the cross-section, attention is focused upon the matrix elements of the field and isotopic spin operators and on the equations of motion, no attempt being made to calculate explicitly the scattering state vector. It is shown that in both the weak and strong coupling limits the procedure described here gives the scattering correctly. For intermediate coupling the cross-section must be found numerically. Computations have been carried out for several intermediate values of the coupling constant and the results are presented in the form of curves showing cross-section *v.* meson energy. Since certain information about the one-nucleon problem (i.e. one real nucleon and no real mesons) is needed for these calculations, a detailed numerical solution of that problem has been carried out using the Tomonaga approximation. The relevant results of this work are presented in several graphs. Although it is not a part of the scattering problem, the calculation of the isobar separation in the strong coupling limit can be carried out so easily by the methods of this paper that a brief account of it is also given. In the appendix, a variational method of calculating the scattering-state vector for intermediate coupling is described. It is shown that this, however, fails to give the correct strong coupling limit. A.

530.145

8059. Renormalization of meson theory with a fixed extended source. G. F. CHEW. *Phys. Rev.*, **94**, 1748–54 (*June* 15, 1954).

It is shown that the procedures for mass and charge renormalization developed by Dyson, Ward and others for a covariant local field theory can be applied in the static or fixed source approximation where the interaction is nonlocal. Reasons are given to show that, although charge renormalization is not necessary in this case because the theory is not divergent, it is nevertheless a very sensible procedure. A.

530.145

8060. Method of approximation for the meson-nucleon problem when the interaction is fixed and extended. G. F. CHEW. *Phys. Rev.*, **94**, 1755–9 (*June* 15, 1954).

It is proposed that a consistent and satisfactory method for evaluating the fixed extended source meson problem is: (*a*) first to renormalize the calculation by the method of the preceding paper (preceding abstract); (*b*) to evaluate the fundamental quantities L_r and Σ_r by the usual weak coupling method; (*c*) also to use standard perturbation theory for the irreducible diagrams except when poles occur in integrations over intermediate states. Sums of diagrams in which repeated poles occur should be evaluated exactly. The proposed method is similar to but not identical with the Tamm–Dancoff approximation. The new method is applied to the pion-nucleon scattering problem. A.

530.145

8061. Intermediate coupling method for meson-nucleon scattering. T. D. LEE AND R. CHRISTIAN. *Phys. Rev.*, **94**, 1760–7 (*June* 15, 1954).

It is shown that for the meson-nucleon scattering processes an intermediate-coupling method can be applied which joins smoothly the results obtained from the weak- and strong-coupling limits. The method is illustrated by a detailed study of the charged scalar meson field with fixed nucleon. A.

530.145

8062. Solutions of Heitler's integral equation by iteration method. S. N. BISWAS. *Phys. Rev.*, **94**, 1767–72 (*June* 15, 1954).

An iterative procedure analogous to Wagner's method for the numerical evaluation of the Fredholm integral equation has been proposed for the solution of Heitler's integral equation on radiation damping. It has been applied to the scattering of mesons by nucleons. The solution for the scattering of π^+-mesons by neutrons agrees with that of Hsueh and Ma, and Goldberger. For the scattering of π^+-mesons by protons, the solution has been taken up to the first approximation; the energy dependence and the angular distribution of the scattering cross-section are shown in the accompanying figures. A.

530.145

8063. Coulomb effects in pion-proton scattering at relativistic energies. F. T. SOLMITZ. Letter in *Phys. Rev.*, **94**, 1799 (*June* 15, 1954).

Expressions are given for the Coulomb spin flip and non-spin flip amplitudes valid for all angles. The effect of the anomalous proton magnetic moment is included through a Pauli term in the Hamiltonian.

P. T. MATTHEWS

530.145

8064. Elastic scattering of pions by nucleons and pion production in nucleon-nucleon collisions. J. L. GAMMEL. *Phys. Rev.*, **95**, 209–16 (*July* 1, 1954).

If the ideas about the pion-nucleon interaction discussed by Chew are taken seriously, it is important to know the accuracy of his calculation of the phase shifts for pion-nucleon scattering resulting from the second-order Tamm–Dancoff approximation. In this paper, exact solutions (found by numerical methods) of the integral equations for the scattering amplitudes resulting from the second-order Tamm–Dancoff approximation are compared with his approximate results. Aitken, Mahmoud and Watson have shown

that a similar integral equation occurs in a theory (based on the same ideas as those discussed by Chew) of pion production in nucleon collisions. The accuracy of their approximate solution of this integral equation is discussed. A.

530.145

8065. Two-body forces and nuclear saturation. I. Central forces. K. A. Brueckner, C. A. Levinson and H. M. Mahmoud. *Phys. Rev.*, **95**, 217–28 (*July* 1, 1954).

The problem of nuclear saturation for the rapidly varying and non-monotonic potentials of pseudoscalar meson theory has been investigated. In these potentials, variational methods using independent-particle trial functions are grossly inadequate. Although the problem can be approached using more general variational functions with interparticle correlation, the evaluation of the resulting expressions is very difficult since indirect correlations involving many more than two particles become important at high densities. An alternative procedure has been developed which allows a rather straightforward evaluation of the many-body energy even when the potentials are of great complexity. This method depends on a treatment of the coherent particle motion which is exact in the limit of very many scatterers, and treats the incoherent motion as a perturbation. In this case the many-body potential energy can be simply expressed in terms of the low-energy scattering amplitudes. This method has been applied to the two-body potentials given by pseudoscalar meson theory when the effects of nucleon pair formation are assumed to be small. In this approximation the many-body forces of the theory are negligible. These potentials give an excellent fit to the low-energy scattering parameters of the two-nucleon system and also an approximately correct description of scattering up to 90 MeV. They are characterized by repulsive cores of radii $0{\cdot}3$–$0{\cdot}4\hbar/\mu c$ and quite weak interactions in odd states. The many-body energy has been evaluated neglecting the tensor contributions which average to zero in first approximation. The result shows saturation at an energy per particle (neglecting Coulomb energy) of 12 MeV at a nuclear radius of $1{\cdot}15\times10^{-13}\,A^{\frac{1}{3}}$ cm. The method has also been applied to potentials of the Lévy type in which the odd-state potentials are rather strong and attractive. To give saturation with these near normal density, a 3-body force of the type given by the pair terms in the pseudoscalar coupling with a coupling constant $g^2/4\pi \sim 3$ is required. Finally, the method can easily be extended to the determination of the elastic interaction of a slow neutron with a nucleus. The resulting "Weisskopf" potential has a depth of 35 MeV. A.

530.145 : 539.185

Correlations in space and time and Born approximation scattering in systems of interacting particles. *See Abstr.* 8679

530.145

8066. Method of solution of the perturbation equations for an arbitrary perturbing Hamiltonian. M. Fabre de la Ripelle. *C.R. Acad. Sci.* [*Paris*] **238**, 1291–3 (*March* 22, 1953) *In French.*

The method given previously by the author [Abstr. 3305 (1952)] for time-independent Hamiltonians is generalized to the case of arbitrary time-dependent perturbations. P. T. MATTHEWS

530.145 : 539.11

8067. Electric polarization of charged particles in square potential wells. J. H. Gibbs. *Phys. Rev.*, **94**, 292–4 (*April* 15, 1954).

The Schrödinger equation is considered for the case of a (charged) particle which is rigidly restricted to a finite region within which it is subject to a linear (electric) potential. Expressions are obtained for the energy and polarization of the quantum levels in the case where the field is small. Exact values for these properties in a stronger field are calculated for a few representative cases. The properties of a canonical assembly of such systems are treated. In particular, the polarization of such an assembly is determined as a function of temperature. A.

530.145

8068. Normalization of WKB-type approximations. S. C. Miller, Jr. *Phys. Rev.*, **94**, 1345–6 (*June* 1, 1954).

A method is developed for normalizing WKB-type approximations to wave-functions for a simple potential well type of problem. The procedure closely resembles Furry's method of finding the normalization for the usual WKB approximations [Abstr. 1383 (1947)]. A.

530.145

8069. Perturbation theory with Sommerfeld–Maue wave function. G. K. Horton and E. Phibbs. *Phys. Rev.*, **94**, 1402–3 (*June* 1, 1954).

The matrix element in the differential cross-section for a process is different if Sommerfeld–Maue rather than non-relativistic wave-functions are employed.

G. E. BROWN

530.162

8070. Correlation functions in the theory of Brownian movement. Generalized equation of Fokker and Planck. P. I. Kuznetsov, R. L. Stratonovich and V. I. Tikhonov. *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 189–207 (1954) *In Russian.*

In Brownian movement the random velocities or accelerations at different times cannot possibly be completely uncorrelated. Taking account of possible statistical correlations the authors formulate conditions for the validity of the differential- and integral equations which are commonly used in the theory of the Brownian movement. R. EISENSCHITZ

530.162

8071. On the description of stationary statistical functions. R. Becker. *Z. angew. Phys.*, **6**, *No.* 5, 231–5 (1954) *In German.*

The relations between the spectral resolution, the correlation and the mean square deviation are developed. Application is made to the theory of the Schrot effect and to Brownian motion.

L. S. GODDARD

530.162 : 535.822

8072. Information theory and uncertainty principle. L. Brillouin, *J. appl. Phys.*, **25**, 887–94 (*July*, 1954).

The methods of information theory are used in the

discussion of observations under a microscope. Conclusions are similar to those obtained in a previous paper and exemplify again the difficulty of measuring extremely small distances. A comparison with the discussion of uncertainty relations shows that quantum uncertainties can be very much higher than the theoretical limit, especially when material screens or shutters are not being used and the observation is made on a free particle. This correction to uncertainty relations, however, does not introduce any change in the theory of quantized fields of Bohr and Rosenfeld. A.

530.162 : 537.533.75 : 537.534.75 : 539.185.7

8073. Application of Markov's method to sequences of energy losses. V. V. CHAVCHANIDZE. *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 179–84 (1954) *In Russian.*

A charged or uncharged particle penetrating matter in bulk loses energy in collisions with atoms. From the probability distribution for energy lost in a single collision, the distribution for energy lost after a number of collisions is derived; result has a relatively simple form; its validity depends on the assumption that successive collisions are statistically independent events. R. EISENSCHITZ

530.162 : 537.533.75 : 537.534.75 : 539.185.7

8074. Markov's method and random energy losses in repeated collisions. V. V. CHAVCHANIDZE. *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 185–8 (1954) *In Russian.*

The author's previous theory (preceding abstract) is not valid if energy losses in single collisions are of a magnitude comparable with the total energy. He obtains an approximate probability distribution for the energy lost in a number of collisions, by substituting the mean loss in the 1st, 2nd, 3rd . . . collision for the actual losses. The resulting expression is not so simple as in the previous case but still suitable for numerical evaluation. R. EISENSCHITZ

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.131.2 : 535.823.5

8075. Parasitic vertical movement of a symmetrical system of guided rods. J. E. PLAINEVAUX. *Nuovo Cimento*, **11**, 626–38 (*June*, 1954) *In French.*

A brief historical review of mechanical arrangements for the rectilinear guidance of elastic rods is followed by an approximate theoretical treatment of a particular compensation system which is used in microscope travelling stages. The treatment is based on the principle of the superposition of small deformations. H. J. H. STARKS

MECHANICAL MEASUREMENTS 531.7

531.714

8076. Photoelectric measurement of the displacement of a light spot. A. THULIN. *C.R. Acad. Sci.* [*Paris*] **238**, 1210–12 (*March* 15, 1954) *In French.*

A divided photoconducting cell with three contacts. Displacements are converted linearly into currents. With stabilized current supply it is shown that it is possible to make the system independent of light fluctuations and of cell sensitivity. J. EWLES

531.714 : 620.172.222

8077. Characteristics and applications of resistance strain gages. *Circ. Nat. Bur. Stand., No.* 528, 140 *pp.* (1954).

Eleven papers, on experimental and theoretical aspects, presented at the NBS Symposium on Resistance Strain Gages in 1951.

531.717.3 : 621.317.79

8078. A capacitance displacement gauge. W. M. TODD. *J. sci. Instrum.*, **31**, 246–7 (*July*, 1954).

Describes the construction and performance of a displacement gauge designed to withstand severe dynamic loading. Trials have been carried out using this gauge to measure displacements of a ship's hull during explosive trials and satisfactory results have been obtained. The gauge is a variable capacitance type which gives a linear change of capacitance with displacement and this change is used to modulate the frequency of a 2 Mc/s carrier. This modulated carrier is then passed through a discriminator circuit and amplified to operate a c.r.o. from which photographic recordings are made. The range of the gauge described covers a movement of 3 in. in the positive phase and 1 in. in the negative phase. The gauge gives a change of capacitance of 11·0 $\mu\mu$F per in. of linear movement and the accuracy is of the order of $\pm 2\%$. A.

531.724 : 541.183

The interaction of rare gas atoms with surfaces. *See Abstr.* 8740

531.787

8079. The construction, operation and performance of a primary standard mercury column for the measurement of high pressures. K. E. BETT, P. F. HAYES AND D. M. NEWITT. *Phil. Trans. A*, **247**, *No.* 923, 59–100 (1954).

The most satisfactory primary pressure gauge for measuring low pressures is the open mercury column, but, for pressures above about 30*b*, the practical difficulties caused by the great height of such a column preclude its use. In order to calibrate free-piston gauges at higher pressures, a column of "reduced height" has been designed and constructed which will measure static pressures up to 2500*b* with an accuracy of $\pm 0{\cdot}15b$ at the maximum pressure. It consists of a mercury-in-steel column some 30 ft high, to each end of which is connected a free-piston gauge. These two gauges are used alternately to record increments of pressure each equal to the pressure exerted by the mercury column. By repeated interchange of the gauges connected to the top and bottom of the column, pressure measurements may be made up to the limit of 2500*b*, for which the column, gauges and accessory fittings are designed. A.

531.787 : 621.316.71.076.7

8080. Design and use of an electronic pressure controller. F. J. DIGNEY AND S. YERAZUNIS. *Analyt. Chem.*, **25**, 921–3 (*June*, 1953).

The controller consists of a simple manometer, one side of which is connected to the reference pressure

and the other to the system being controlled, the whole being submerged in a constant temperature bath. Three electrodes are provided, one, a common electrode in constant contact with the manometer fluid, the other two in the manometer arms and making contact when unbalance occurs. The electrodes are connected to the mains-driven 4-tube electronic unit. The latter includes 3 relays, one operating at ~2/sec, the other two serving as on/off switches and actuated when the electrodes make contact. These two relays in turn operate valves in the pressure and vacuum tank lines to correct the pressure, the valve action being pulsating due to the first relay. An automatic temperature contro ler for the bath is also described. The equipment maintains constant pressure within $\pm 0{\cdot}1$ mm of Hg over several months. Absence of hunting is attributed to the low relative pressures, 5–10 mm, of the pressure and vacuum tanks.

H. G. M. SPRATT

MECHANICS OF FLUIDS 532

532.122

8081. The critical evaluation of compression data for liquids and a revision of the isotherms of mercury. K. E. Bett, K. E. Weale and D. M. Newitt. *Brit. J. appl. Phys.*, **5**, 243–51 (*July*, 1954).

It is shown that Hudleston's equation represents liquid compression data at least as accurately as Tait's equation, and the straight line isotherms obtained are more convenient for the estimation of random experimental errors. The equation may also be used to extrapolate and interpolate measurements over a large P–T region. Revised values for the isothermal compression of mercury from −30 to 150°C and up to 12 000 kg/cm² have been obtained by using the equation to correlate existing measurements with more recent sound-velocity determinations. Some thermodynamic derivatives for mercury are also calculated. A.

532.14 : 532.612.4

8082. The density and surface tension of liquid fluorine between 66 and 80°K. D. White, J.-H. Hu and H. L. Johnston. *J. Amer. Chem. Soc.*, **76**, 2584–6 (*May* 5, 1954).

The density of liquid fluorine between 66·03 and 77·22°K is a linear function of temperature, given by the relationship: $d = 1{\cdot}5127 + 0{\cdot}00635(T_B - T)$, where d is the density in g/cm³ at temperature T, and T_B is 85·02°K, the normal boiling point of fluorine. The uncertainty in the density is estimated at $\pm 0{\cdot}1\%$. The results on the surface tension, in the temperature region 66·21 to 79·90°K, can be represented by the MacLeod equation: $\gamma^{1/4}/(d - d') = C$, where γ is the surface tension in dyne cm^{-1}, d the density of the liquid, d' the density of the gas and C a constant equal to $1{\cdot}276 \pm 0{\cdot}002$. Estimated experimental uncertainty in the surface tension determinations is $\pm 1\%$. A.

532.14 : 539.155.2

8083. The density of heavy water and the electrolytic enrichment of the oxygen isotope. V. P. Isberg and L. Lundberg. Note in *Z. Naturforsch.*, **9a**, 472–3 (*May*, 1954) *In German.*

On the basis of a determination of the molecular ratios O^{17}/O^{16} and O^{18}/O^{16} in Norwegian heavy water a reappraisal of the density of heavy water gives $d_{20}^{20}(n) = 1{\cdot}10735 \pm 0{\cdot}00001$. As a result of the correction the densimetric determination of deuterium in concentrated heavy water is affected to the extent of $0{\cdot}1\%$. W. GOOD

532.5 : 538.566

Dimensional relations in magneto-hydrodynamics. *See Abstr.* 8447

CAPILLARITY 532.6

532.612

8084. Dependence of surface tension on temperature. S. S. Mitra. Letter in *J. chem. Phys.*, **22**, 1134–5 (*June*, 1954).

Two alternative empirical formulae are given, both of which give values in agreement with experiment for associated and non-associated liquids. T. C. TOYE

532.623

8085. Bursting of bubbles at an air-water interface. D. C. Blanchard; D. M. Newitt. Letters in *Nature* [*London*] **173**, 1048, 1048–9 (*May* 29, 1954).

The suggestions of Knelman *et al.* [Abstr. 5335 (1954)] on the mechanisms involved in the bursting of bubbles are questioned, the author considering that they apply only to large bubbles. Newitt confirms that the bubbles were large but thinks his theory will hold for smaller bubbles. [See also Abstr. 2954 (1954).] T. C. TOYE

532.65

8086. Instability of liquid surfaces and the formation of drops. J. B. Keller and I. Kolodner. *J. appl. Phys.*, **25**, 918–21 (*July*, 1954).

The theory of Taylor instability is extended to take account of surface tension, and the most unstable mode is determined. The resulting theory is then used to estimate the size of drops which might be formed as a result of this instability. A.

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

8087. Theory of energy zones for a one-dimensional model of a liquid. A. I. Gubanov. *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 139–49 (1954) *In Russian.*

In order to find the energy levels of an electron in the field of a linear disordered chain of atoms, the author transforms the wave equation to a new co-ordinate. This is distorted in such a way that the potential energy is reduced to strict periodicity. The terms by which the new wave equation differs from the periodic field wave equation, are regarded as being small and expanded in powers of a perturbation parameter. By applying perturbation theory to the first and second order the energy spectrum is readily derived; it is shown that the familiar band structure persists in the liquid state. The result applies to real

liquids only if their structure is as nearly periodic as the author's model. R. EISENSCHITZ

532.7 : 541.57

Hydrogen bonding and the volume of water. *See Abstr.* 8745

532.72

8088. Effect of pressure on diffusion in polymer solutions. A. H. EMERY, JR, L. H. TUNG AND H. G. DRICKAMER. *J. chem. Phys.*, **22**, 961–4 (*June*, 1954).

Diffusion measurements have been made using two molecular weights of polysulphide polymer at 25°C and 59°C in toluene solution. One isotherm for the low molecular weight was obtained in chloroform solution. The results indicate that there are two mechanisms of motion in solution. At low pressure the dominant mode involves the expulsion of a solvent molecule from the coiled polymer. At high pressure the motion is segmental. A.

532.73

8089. On the limits of application of Raoult's law to ideal dilute solutions. Y. DOUCET AND G. PETIT. Letter in *J. Phys. Radium*, **15**, 302–3 (*April*, 1954) *In French.*

For dilute solutions, the formula expressing the law of Schröder and van Laar can be expressed as a series broken off at the term smaller than experimental error, in practice the second. Calculations on molten cryolite, lithium borate and sodium chloride indicate that there is a region of dilution where Raoult's limiting law holds for an ideal solution. For arbitrary concentrations, however, the criterion of ideality is the law of van Laar. A. J. TAYLOR

532.73 : 536.75

8090. On the criterion of "ideality" of thermal diagrams. G. PETIT. Letter in *J. Phys. Radium*, **15**, 301–2 (*April*, 1954) *In French.*

A strong electrolyte added to another may give solutions ideal over great temperature ranges, but one added to a non-electrolyte may give ideality only over a more restricted (high temperature) range. Entropy changes due to differing shapes of ions and radicals are likely to be important only in concentrated solutions. Non-ideality in concentrated solutions can be due to a variety of causes; as it is difficult to find a case of only one cause being operative, only dilute systems are considered. The solution of TiO_2 in cryolite is used as an illustration. A. J. TAYLOR

532.77

8091. On the theory of the Maxwell effect of solutions of macromolecules in chains: influence of the permeability. R. CERF. *C.R. Acad. Sci.* [*Paris*] **238**, 1403–5 (*March* 29, 1954) *In French.*

The theory previously proposed [Abstr. 2250 (1953)] for the Maxwell effect of suspensions of elastic spheres is developed to explain the behaviour of macromolecules in solution. G. I. W. LLEWELYN

532.77 : 534.23

Measurements of sound absorption in aqueous solutions of electrolytes. *See Abstr.* 8113

532.782

8092. Further studies of the supercooling of drops of some molecular liquids. H. J. DE NORDWALL AND L. A. K. STAVELEY. *J. Chem. Soc.*, **1954**, 224–7 (*Jan.*).

For earlier work, see Abstr. 3013 (1953). Further experiments have been carried out on the extent to which liquid drops may be supercooled, by observation of clouds of droplets in a beam of light at different temperatures. For seven of the 21 liquids examined, it was possible to determine T_c, the mean temperature of the comparatively narrow range in which freezing appeared to start in these circumstances. For these liquids, values of the interfacial free energy between crystal and liquid have been derived, and compared with previous results. Some remarks are made on the possible reasons for failure to observe crystallization in experiments of this kind. A.

MECHANICS OF GASES 533

533.15 : 532.7 : 539.217

8093. Diffusion coefficient, solubility, and permeability for helium in glass. W. A. ROGERS, R. S. BURITZ AND D. ALPERT. *J. appl. Phys.*, **25**, 868–75 (*July*, 1954).

A method is described for simultaneously measuring the diffusion coefficient, solubility, and permeability for a given gas in a single sample of solid material. The method utilizes solutions of the diffusion equation (for both plane and cylindrical geometry) which make it easily possible to calculate the diffusion parameters from data taken either in the period of steady-state gas flow or in the early part of the transient period. Using ultra-high vacuum techniques, it is possible to make the measurements with extremely small amounts of gas and without errors due to leaks or contamination in the gas handling system. Values for the diffusion parameters have been determined for helium in Pyrex glass (Corning 7740), and comparisons with previous measurements are made. Directly measured values of the diffusion coefficient are given for the first time. The diffusion coefficient and permeability both exhibit a temperature dependence of the form $\exp(-E/kT)$ both having the same activation energy ($6{\cdot}4\times10^3$ cal/mole) within the experimental error. The solubility exhibits little or no variation with temperature over the range 25°C to 300°C, and is in good agreement with the only previous measurement, carried out at 515°C. A.

533.15 : 532.73

8094. Permeability and solubility of He^3 and He^4 in vitreous silica. W. M. JONES. *J. Amer. Chem. Soc.*, **75**, 3093–6 (*July* 5, 1953).

The relative permeabilities and solubilities of He^3 and He^4 in vitreous silica have been measured as a function of temperature, and the differences in the diffusion activation energies and heats of solution evaluated. The absolute permeabilities and solubilities also were obtained. A.

533.15 : 536.23

8095. The thermal diffusion factor and temperature. K. E. GREW, F. A. JOHNSON AND W. E. J. NEAL. *Proc. Roy. Soc. A*, **224**, 513–26 (July 22, 1954).

The thermal diffusion factor has been measured for several gas mixtures in a range of temperature which included that at which the reversal of sign,

predicted theoretically when a Lennard–Jones type of interaction is assumed, might be observed. A reversal was found with hydrogen–deuterium, nitrogen–argon, oxygen–argon and nitrogen–carbon dioxide mixtures; with neon–argon, argon–krypton and krypton–xenon mixtures no reversal was observed, the thermal diffusion factor having a small positive value at the lowest temperatures at which measurements could be made. A comparison of the experimental values of the thermal diffusion factor with values calculated for the Lennard–Jones (13, 7) model shows that this model is not quantitatively satisfactory. A.

533.16 : 536.48

8096. Viscosity of gaseous He^3 and He^4 between 1·3°K and 4·2°K. E. W. Becker, R. Misenta and F. Schmeissner. *Z. Phys.*, **137**, *No.* 1, 126–36 (1954) *In German.*

Authors' viscometer consists of an aluminium cylinder oscillating about its axis in a circular 0·9 mm gap, a rotating magnetic field being employed for the initial deflection. A fixed plate and the lid of the cylinder are adjusted so that they form a condenser the capacity of which is proportional to the angle of deflection. The capacity is, by means of an a.c. bridge, recorded photographically as a function of the time. From the recorded graph the logarithmic decrement and, hence, the viscosity of the gas in the gap, are derived with an error $<\pm 1\%$. Results obtained are found to be in accordance with theoretical viscosity-temperature curves [Abstr. 1528, 5592 (1952)] which depend sensitively on the symmetry character of the translational molecular wave-functions. The fact that He^4 is a Bose–Einstein gas and He^3 is a Fermi–Dirac gas is accordingly demonstrated here for the first time by direct observation.

R. EISENSCHITZ

533.21

8097. Compressibility of ammonia at pressures up to 10 000 atmospheres. D. S. Tsiklis. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 4, 889–90 (1953) *In Russian.*

533.21 : 539.893

8098. Compressibility of argon at a high adiabatic compression. Yu. N. Ryabinin, A. M. Markevich and I. I. Tamm. *Zh. éksper. teor. Fiz.*, **24**, *No.* 1, 107–13 (1953) *In Russian.*

The measurements [for apparatus see Abstr. 5741 (1953)] were conducted at pressures 2100–7000 kg/cm², the corresponding gas density varying from 0·175 to 0·360 g/cm³. The following magnitudes were calculated from the results: Poisson coefficient, coefficient of adiabatic compression, density and speed of sound; the calculated values are very close to those for a perfect gas. F. LACHMAN

533.5 : 531.788

8099. A quartz-coated wire Pirani gauge. J. H. Leck. Letter in *J. sci. Instrum.*, **31**, 226–7 (*June*, 1954).

As Pirani filaments of tungsten and platinum have certain disadvantages at temperatures above 600°K, the use of a quartz-coated filament is suggested. This type of filament is accurate to within $\pm 2\%$ for pressures from zero to 5 mm Hg at ~900–1000°K. At high pressures and over prolonged operating periods (above 100 hr), errors may rise to $\pm 5\%$. The zero drift is negligible. The fragility of quartz-coated wire, the necessity for removing the coating by hydrofluoric acid at the ends to obtain an electrical contact, and the inapplicability of helical construction to increase its effective length, are the practical disadvantages of quartz-coated wire. G. WITTENBERG

533.6.013.22 : 537.523.3

8100. On the use of corona discharges in the measurement of turbulence and turbulence components. W. Fucks. *Z. Phys.*, **137**, *No.* 1, 49–60 (1954) *In German.*

A continuation of earlier work by the same author on the use of corona (e.g. in point-plane or point-point gap configurations) in gas flow studies. The present paper gives detailed data on corona characteristics with and without air flowing at known speeds past the discharge gap. The techniques for studying turbulent motion are discussed analytically.

J. D. CRAGGS

MOLECULAR THEORY OF GASES 533.7

533.7

8101. On most probable distributions. P. T. Landsberg. *Proc. Nat. Acad. Sci. U.S.A.*, **40**, 149–54 (*March*, 1954).

In the determination of most probable occupation numbers (occ. no.) for an assembly of independent particles, Stirling's approximation is avoided by the use of Gauss's Ψ function. It is also shown that for certain cases (small occ. no.) the "assumption of continuity" (of occ. no.) actually excludes the most probable distribution. F. ANSBACHER

533.7 : 536.2

8102. Effect of specular reflection on gaskinetic heat transmission and friction. E. Sänger. *Z. Naturforsch.*, **9a**, 410–18 (*May*, 1954) *In German.*

In calculating the flux of momentum and energy through a solid surface in contact with a flowing gas, the author assumes that gas molecules collide with single atoms in the solid; apart from this assumption familiar kinetic theory is applied. Expressions for the coefficients of heat transfer and surface friction are obtained showing the specific contribution of elastic collisions which author considers as being important for supersonic flight. Conditions for specular reflection are discussed. R. EISENSCHITZ

533.7 : 536.71 : 519.2

8103. Further results on Monte Carlo equations of state. M. N. Rosenbluth and A. W. Rosenbluth. *J. chem. Phys.*, **22**, 881–4 (*May*, 1954).

The equation of state of three-dimensional hard spheres has been obtained by the Monte Carlo method. Some qualitative results for a system of two-dimensional molecules with Lennard–Jones interaction are also given, as well as a general discussion of the usefulness and limitations of the Monte Carlo method. A.

VIBRATIONS . ACOUSTICS 534

534.22/.23

8104. An impulse apparatus for the measurement of absorption and phase velocity of ultrasonic waves in liquids. Measurement in liquid naphthalene. G. BUSCH AND W. MAIER. *Z. Phys.*, **137**, *No.* 4, 494–502 (1954) *In German.*

A high-frequency impulse apparatus is described and shown to be capable of an accuracy of 1% in the measurement of α and of 0·1% in the measurement of phase velocity in magnetically oriented crystalline liquids between 0 and 130°C. Results for the one liquid are given. T. C. TOYE

534.22 : 532.7 : 536.44

8105. Propagation of ultrasonics in carbonic acid in the neighbourhood of the critical point. H. TIELSCH AND H. TANNEBERGER. *Z. Phys.*, **137**, *No.* 2, 256–64 (1954) *In German.*

Using an ultrasonic high-pressure interferometer, measurements of velocity have been made at a frequency of 410 kc/s. Anomalies in the velocity pressure function do not agree with other work at other frequencies in which, in fact, there is a lot of disagreement among various published results. A method of calculation of specific heat is given.

T. C. TOYE

534.22 : 539.32

8106. Velocity of elastic waves in the solidified inert gases. T. H. K. BARRON AND C. DOMB. Letter in *Phil. Mag.*, **45**, 654–5 (*June*, 1954).

The authors describe calculations they have made in an attempt to relate with theory the results of measurements by Barker, Dobbs and Jones [see Abstr. 1785 (1954)] on the velocity of propagation of longitudinal elastic waves in solid argon. These calculations yield velocities lower than those observed experimentally but it is expected that when certain corrections can be made the discrepancy will be smaller. H. J. H. STARKS

534.22.08 : 536.48

8107. Apparatus to measure the velocity of sound down to liquid helium temperatures with the optical method. A. VAN ITTERBEEK, G. J. VAN DEN BERG AND W. LIMBURG. *Physica*, **20**, 307–10 (*May*, 1954).

Debye and Biquard's optical method, in which the sound wave sets up a diffraction grating in the liquid, is adapted for use at low temperatures. Results have been obtained with liquid N_2, H_2 and He.

T. C. TOYE

534.222.1

8108. On a case of propagation of sound in a non-homogeneous medium. L. M. BREKHOVSKIKH. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 5, 715–18 (1952) *In Russian.*

See also Abstr. 5627 (1949). Analyses the acoustic field in a non-homogeneous stratified medium in which the velocity of sound depends as follows on the co-ordinate z: $c = c_0$ for $0 \leqslant z \leqslant h$, and $c = c_0/[1 + 2a(z - h)]^{\frac{1}{2}}$ for $h \leqslant z \leqslant \infty$, remaining constant in planes at right angles to the z axis. The boundary $z = 0$ is assumed to be totally reflecting, and the source has a point form. The special case of $h = 0$ was dealt with by Pekeris [Abstr. 245 (1947)] and Morse [Abstr. 1680 (1951)]. F. LACHMAN

534.222.2

8109. Approximate representation of intense non-stationary shock waves by homologue solutions. C. F. v. WEIZSÄCKER. *Z. Naturforsch.*, **9a**, 269–75 (*April*, 1954) *In German.*

The equations of continuum, momentum and entropy are invariable with respect to changes of the units of length, time and density and therefore possess symmetrical (homologous) solutions invariable with respect to the same group of units. For the case of a strong, nonstationary, plane shock wave, these equations are reduced to a system of ordinary differential equations by suitable substitutions and then solved numerically. A. GELBTUCH

534.222.2

8110. The solution of the Boltzmann equation for a shock wave using a restricted variational principle. P. ROSEN. *J. chem. Phys.*, **22**, 1045–9 (*June*, 1954).

Using a variational method and the Mott–Smith velocity distribution function, the thickness of a plane shock wave is calculated for various Mach numbers. The results compare fairly well with those obtained by Mott–Smith. It is also shown that the Mott–Smith distribution function becomes a better choice as the Mach number increases. A.

534.222.2 : 535.417

8111. On the interaction of two plane shocks facing in the same direction. O. LAPORTE AND E. B. TURNER. Letter in *J. appl. Phys.*, **25**, 678 (*May*, 1954).

The production of two shock waves, facing in the same direction, and separated by a constant state, is accomplished by blocking the test section of a shock tube by a comb-like stack of plates spanning the width of the tube. Interaction between two plane shocks, so generated, shown by interferograms, taken with white light, is briefly discussed. Density changes inferred from the fringe-shifts agree with theoretical results. Schlieren photographs reveal the interface with considerable sharpness.

J. S. G. THOMAS

534.23 : 532.7

8112. Investigation on the absorption of ultrasound in the series of saturated hydrocarbons using the pulse method. N. I. KOSHKIN AND V. F. NOZDREV. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 4, 793–6 (1953) *In Russian.*

Describes the method used, and graphs and tabulates some of the results. The generator (synchronized with the sweep circuit of the cathode-ray oscillograph) generates radio-pulses with carrier frequencies of 5–30 Mc/s and durations of 2 . . . 6 . . . 10 μsec, which are fed into a quartz transducer immersed into the liquid examined and, simultaneously, through an attenuator, into the input of the receiver. The ultrasound is reflected by a suitable reflector back to the transducer where it is changed into an electric pulse. It is claimed that the absorption can be determined by this method with an accuracy of 2–3%. The hydrocarbons examined were: *n*-hexane, *n*-heptane and *n*-octane, and the temperature range −60 to 60°C. The absorption curves for these hydrocarbons pass through a flat minimum, rising more steeply towards the lower than

towards the higher temperatures. The results obtained agree with the Stokes–Kirchhoff relationship $\alpha/\nu^2 = \text{const.}$, the only greater discrepancy occurring for *n*-octane near its melting-point. The formula $(\alpha_e/\nu^2)MV_0^3 = f(T/T_{cr})$, where α_e is the experimentally determined coefficient of absorption, ν the frequency of ultrasonic oscillations, M—the molecular weight, V_0—the velocity of ultrasound, T—the absolute temperature, T_{cr}—the absolute critical temperature, and $f(T/T_{cr})$—a function of the reduced temperature, identical for all saturated hydrocarbons, has been found to be in agreement with the results.

F. LACHMAN

534.23 : 532.77

8113. Measurements of sound absorption in aqueous solutions of electrolytes. K. TAMM, G. KURTZE AND R. KAISER. *Acustica*, **4**, *No.* 3, 380–6 (1954).

In continuation of investigations on sound absorption in aqueous solutions of electrolytes [Abstr. 2129 (1954)], the frequency range of 5 kc/s . . . 100 Mc/s has been extended to 300 Mc/s by a new apparatus using pulses. The results for the most interesting electrolytes are given. To confirm the explanation for the electrolyte absorption, experiments have been made with respect to the influence of incomplete dissociation by using either electrolytes with well-known incomplete dissociation in water or solvents with a lower dielectric constant. The results given are in agreement with this explanation. In a short theoretical consideration formulae are given which allow the calculation of the maximum "absorption volume" $(Q\lambda)_{max}$ and the relaxation frequency from the dissociation constant and the partial molar volumes of the reacting ions. A.

534.231

8114. Variational principles for the acoustic field. E. GERJUOY AND D. S. SAXON. *Phys. Rev.*, **94**, 1445–58 (*June* 15, 1954).

Variational principles are presented for the scattering amplitude in the general acoustic scattering problem, and, for spherically symmetric scatterers, for the phase shifts. Integral equations for the acoustic field are also given and the properties of the scattering matrix are developed. The entire formulation remains valid in the presence of discontinuities of density and/or velocity in the medium. A.

534.231.3

8115. The determination of the overall mechanical impedance of solids in the frequency band 50–3000 c/s. W. ELLING. *Acustica*, **4**, *No.* 3, 396–402 (1954) *In German.*

With the electromechanical vibrometer described the mechanical impedance of walls, ceilings and homogeneous aluminium plates in absolute value and phase has been determined. The measured values cover a range of about 10^4 . . . 10^9 dyne . sec/cm (10 . . . 10^6 Ns/m). The measurements show that the imaginary part of the impedance of ceilings and walls is an inertance at low frequencies and a stiffness at high frequencies. The change-over occurs round about 150 . . . 300 c/s, where the real part of the impedance has a maximum. Model measurements on aluminium plates highly damped at the edges agree well at high frequencies with theory. A.

534.232

8116. Generators of ultrasound in air, with vibrating cylinders, pistons, spheres and cubes. V. GAVREAU AND M. MIANE. *Acustica*, **4**, *No.* 3, 387–95 (1954) *In French.*

Electrodynamic ultrasonic sources made of solids vibrating in resonance; advantages of this type for acoustic measurements; possibility of obtaining large acoustic power from them; focusing; re-generative systems for high frequencies; methods of making the ultrasonic vibrations visible; study of the vibration of the emitting surfaces; audibility of high-frequency sounds; application to the absolute calibration of microphones at ultrasonic frequencies. A.

534.232 : 621.395.623.7

8117. The upper frequency limit of cone-type loudspeakers. T. NIMURA AND E. MATSUI. *J. Inst. Elect. Commun. Engrs Japan*, **35**, 447–51 (*Oct.*, 1952) *In Japanese.*

Analysis of the static deformation of a truncated conical shell shows that most of the deformation occurs along the inner edge. The part played by this edge effect when the shell is driven axially by the voice coil is considered. It is suggested that the compliance can be regarded as concentrated along the inner edge of the shell, between the voice coil and the cone. Its value depends on the apical angle of the cone, the thickness of the shell, the minor radius, Young's modulus and especially on whether the inner edge is allowed to vibrate radially or not. The mechanical resonance of the voice-coil mass with the above compliance determines the upper limit of the loudspeaker pressure response characteristic. Measured resonance frequencies of cones of various shapes and sizes agree with calculated values.

A. WILKINSON (R)

534.232 : 621.395.623.7–233

8118. On the extensional vibration of loudspeaker cones. T. NIMURA AND K. SHIBAYAMA. *J. Inst. Elect. Commun. Engrs Japan*, **35**, 260–8 (*June*, 1952) *In Japanese.*

Theory is given of the extensional vibrations of conical shells, neglecting bending effects. A graphical method was adopted for the solution of the vibrational equation. The results indicate how the vibrations of conical shells are related to those of circular plates, bars and cylinders. Formulae are derived for the resonance and antiresonance frequencies of loudspeaker cones which are sufficiently accurate for practical design. Experimental results confirm the theory. A. WILKINSON (R)

534.44

8119. Investigation of aperiodic time events using auto-correlation and Fourier analyses. M.-L. EXNER. *Acustica*, **4**, *No.* 3, 365–79 (1954) *In German.*

Auto-correlation and frequency analyses of a series of aperiodic time events, especially filtered noises and hisses, have been made. The position and bandwidth of the frequency range are best obtained from the frequency analysis but the energies contained in the several bands are most easily obtained from the auto-correlation function. The mean number of null-points of the time function is estimated from the curvature of the latter function in the vicinity of the

null-point and also with the aid of a decimal counter. The second method is found to be more exact. A.

534.6

8120. The calibration arrangements used in the acoustic department of the C.N.E.T. P. CHAVASSE AND P. RIÉTY. *Ann. Télécomm.*, **9**, 58–72 (*March*, 1954) *In French.*

The various calibration measurements made on electroacoustic apparatus are reviewed. A description is given of the apparatus used both for the classical measurements and also for physiological acoustic research. Apparatus is described in detail. See also abstract following. G. F. HODSMAN

534.6

8121. The calibration arrangements used in the acoustic department of the C.N.E.T. P. CHAVASSE AND P. RIÉTY. *Ann. Télécomm.*, **9**, 94–8 (*April*, 1954) *In French.*

The paper reported in the preceding abstract is concluded. Special reference is made to apparatus used for audiometric measurements. G. F. HODSMAN

534.6 : 621.375.2.029.4

8122. The use of variable-gain amplifiers in acoustic measurements. A. MOLES. *Rev. gén. Elect.*, **63**, 35–52 (*Jan.*, 1954) *In French.*

For such measurements a small condenser microphone with reasonably level frequency response can be found but the same does not apply to any available loudspeaker intended for use as a sound source while the cost of a good anechoic room is prohibitive. However, given a reasonably dead room, a small calibration microphone, a variable-gain amplifier, variable l.f. oscillator and a recording meter, satisfactory measurements can be carried out in either of two ways: (*a*) the variable-gain amplifier is included between the oscillator and loudspeaker and is controlled by the calibration microphone, thereby ensuring a constant sound-pressure field around the latter; or (*b*) the variable-gain amplifier is included between the test, or exploring, microphone and the recording meter, control being effected as in (*a*). Method (*b*) is particularly satisfactory with two nearly identical microphones available, for investigating the absorbing and reflecting properties of walls, etc. The circuit of the amplifier with its two variable-gain stages is described. Families of frequency-response curves show the results of various tests.

H. G. M. SPRATT (R)

534.64

8123. Acoustic impedance measurement using a resonance method. M. A. FERRERO AND G. G. SACERDOTE. *Acustica*, **4**, *No.* 3, 359–64 (1954).

The method of C. M. Harris for acoustic impedance measurements, in which a system is brought to resonance, is theoretically discussed and extended. Some experimental results obtained with equipment applying the method are also reported. A.

OPTICS . RADIATION . SPECTRA 535

535.223

8124. Precision determination of the velocity of light derived from a band spectrum method. II. D. H. RANK, J. N. SHEARER AND T. A. WIGGINS. *Phys. Rev.*, **94**, 575–8 (*May* 1, 1954).

For Pt I, see Abstr. 100 (1953). The rotational constant B_{000} for HCN has been measured using the method of exact orders for the 002 infrared rotation vibration absorption band. The value obtained is $1{\cdot}478\,23_5\ \mathrm{cm}^{-1}$. Combined with the microwave measurements by Nethercot and Klein of the same constant in pure frequency units, a value for the velocity of light, $c = 299\,789{\cdot}8 \pm 3{\cdot}0$ km/sec, is found. The change in the apparent thickness of the Fabry Perot interferometer with wavelength due to the phase shift in the ZnS, MgF_2, ZnS coated plates is discussed and the experimental results compared with the calculated values. The rotational constants $\alpha_3 = 0{\cdot}010\,03_4$ and $\gamma_{33} = 0{\cdot}000\,18_3\ \mathrm{cm}^{-1}$ were also obtained with the aid of other interferometric results. A.

535.23/.24

8125. Some remarks about the so-called Crova wavelength. W. DE GROOT. *Philips Res. Rep.*, **8**, 401–10 (*Dec.*, 1953).

It is shown that it is of minor importance whether the Crova wavelength λ_C is defined with the aid of Planck's or Wien's radiation formula, both definitions leading to approximately the same result. If $V(\lambda)$, the relative spectral luminous efficiency, is approximated by a Pearson function, λ_C is a linear function of T^{-1}. It is shown that the relative luminous efficiency of a perfect radiator is approximately maximum if $\lambda_C T = c_2/4$ or $\lambda_m T = c_2/4$, in which λ_m is the wavelength for which $V(\lambda) = 1$. It is further shown that the theoretical value of the maximum spectral luminous efficiency, K_m, as deduced from the definition of the candela, depends on the values assigned to c_1 and to the ratio C_2/T_{Au} (T_{Au} = melting temperature of gold). In first approximation

$$\frac{\mathrm{d}K_m}{K_m} = -\frac{\mathrm{d}c_1}{c_1} + \frac{1}{\lambda_C(T_{\mathrm{Pt}})}\mathrm{d}\frac{c_2}{T_{\mathrm{Au}}}.$$

The luminance of a perfect radiator is given in terms of λ_C. A.

535.231.2

8126. Emissive power of a cylindrical black body. C. L. SANDERS AND B. A. STEVENS. *Rev. opt.*, **33**, 179–80 (*April*, 1954) *In French.*

Examines the reflection conditions inside a perfectly-diffusing hollow enclosure and shows that the results obtained by Gouffé's method [Abstr. 3107 (1946)] cannot be applied to the cylinder, although they are valid for the sphere. The end of a long cylinder gives a better approximation to black body conditions than the bottom of a sphere of the same max. dimension. J. W. T. WALSH

535.242

8127. Photometry at low luminance levels. W. DE GROOT. *Philips tech. Rev.*, **15**, 182–7 (*Dec.*, 1953).

In photometry the observer makes himself independent of the variance of brightness impression by always comparing two patches of light which produce about equal brightness impressions. In the region of high brightnesses an efficiency function of the human eye has been standardized (C.I.E., 1924). The definition of luminance is based on this function. The unit

of luminance is the cd/m² or "nit." At low luminances (< 3cd/m²) equality of luminance does not correspond to equality of brightness impression. Following Bouma, "subjective brightness" is defined as the luminance of the comparison field, illuminated by a special source, which in the photometer appears equally bright with the field to be measured. For this source, Bouma chose monochromatic light ($\lambda = 535$ mμ). Another often recommended choice is a source of colour temperature $T_c = 2360°$K. In 1951 the C.I.E. recommended a source with $T_c = 2042°$K (black body at the freezing temperature of platinum, on which the definition of the candela is also based). At the same time, an efficiency curve for the region of lowest brightnesses (scotopic region) was standardized. It is now possible to express the "subjective brightness" in cd/m², and to use the units lumen, lux, etc., also in this region. In order to avoid misunderstanding, however, it is advisable to mark these units with the suffix: scotopic or photopic. In scotopic photometry use can be made of other standard sources (e.g. $T_c = 2360°$K, $T_c = 7500°$K), but in this case the measured luminances must be multiplied by a correction factor in order to reduce them to the luminance of an equally bright field, illuminated by the candela source. A.

535.317

8128. Asymptotic evaluation of the field at a caustic. I. KAY AND J. B. KELLER. *J. appl. Phys.*, **25**, 876–83 (*July*, 1954).

The asymptotic expansion of wave fields in powers of $1/k$ for large k, where k is the wave number, has as its lowest-order term what is commonly known as the geometrical optics field. The caustics of geometrical optics are those point sets on which the zero-order terms become infinite. It is well known that caustics may exist even where the exact wave field is perfectly regular. An investigation of reflection from cylindrical walls of arbitrary cross-section shows that the occurrence of caustic points means a change in character of the asymptotic expansion of the true field such that the lowest-order term is no longer independent of k but actually contains a factor k raised to a positive power. There also occurs a jump in phase along a ray passing through a caustic which, as is well known, equals $\pi/2$. As an application of the general method, the geometrical optics field is worked out in detail for the case of a plane wave incident on a parabolic cylinder, and the field is obtained in its lowest order at the focus and in the neighbourhood of the focus. A similar problem for a reflector consisting of a segment of a circular cylinder is also considered in detail. A.

535.317.6

8129. A criterion of the state of correction of a ray bundle. F. I. HAVLIČEK. *Optik*, **11**, *No.* 5, 249–51 (1954) *In German.*

A simple semi-graphical method is described allowing the minimum wavefront errors to be determined from the variation of ray intersection points with angle. The method is illustrated for the case of a simple microscope objective. R. W. FISH

535.321

8130. Two new photometric methods for the determination of the optical constants of solids. F. ABELÈS. *C.R. Acad. Sci.* [*Paris*] **238**, 1983–5 (*May* 17, 1954) *In French.*

The complex refractive index of an absorbing solid, n–ik, can be determined from measurements of the normal incidence reflection coefficient, together with a second measurement at oblique incidence, for light polarized either parallel to the plane of incidence, for cases where $k < n$, or perpendicular to that plane for $k \sim n$, as for metals. D. G. AVERY

535.33.03 : 536.46 : 536.52

Measuring the temperature of a flame by the spectral line inversion method. *See Abstr.* 8238

535.33.03 : 537.523.4

8131. A study of the [light] emission mechanism in Tesla sparks. H. TRICHÉ AND P. SALFATI. *C.R. Acad. Sci.* [*Paris*] **238**, 1654–6 (*April* 21, 1954) *In French.*

A general brief discussion of the emission spectra produced by Tesla discharges in various gases.

J. D. CRAGGS

535.33.03 : 537.523.4 : 551.594.221

8132. The comparison of the spectra of long sparks in air and of lightning. A. VASSY. *C.R. Acad. Sci.* [*Paris*] **238**, 1831–3 (*May* 3, 1954) *In French.*

A brief general discussion of resemblances between certain aspects of the long spark spectra (which may be divided, on a time scale, into three régimes) and lightning spectra. The OI and NI lines appear to show the greatest divergences, being strong in lighting and weak in sparks. J. D. CRAGGS

535.33.03 : 537.525 : 539.132

8133. Dissociative recombination at surfaces. K. G. EMELÉUS. Letter in *Proc. Phys. Soc.* [*London*] *B*, **67**, 495 (*June*, 1954).

Suggests that the richness of the spectrum of the cathode glow in lines of neutral gas atoms for discharges in diatomic molecular gases might be due to this process. J. DUTTON

535.33.07 : 535.339–32 : 621.383 : 537.312.5

Fabrication of photoemissive receivers for the far ultraviolet. Photoemissive cells and electron multipliers. *See Abstr.* 8301

535.33.07 : 535.375.5

8134. A glass spectrograph with a plane grating and of high light-gathering power. Some of its applications in Raman spectroscopy. YA. S. BOBOVICH AND M. M. PAKHOMOVA. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 5, 947–50 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-222.*

An echellette grating is used with an $F/2$ camera for the Raman spectra of coloured materials excited by $\lambda = 5461$ Å. Microphotometer traces of some Raman spectra obtained with exposures of about 5 min, indicate a resolution of about 10 cm^{-1}. G. F. LOTHIAN

535.338.33 : 539.152.2

8135. The arc spectrum of iodine and the quadrupole moment of I^{127}. K. MURAKAWA AND S. SUWA. *Z. Phys.*, **137**, *No.* 5, 575–82 (1954) *In German.*

Very sharp lines were obtained by means of a high-frequency discharge in a capillary tube. The h.f.s. was studied by means of a Fabry–Pérot interferometer. Analysis of results led to the value $Q(I^{127}) = (-0{\cdot}75 \pm 0{\cdot}02)10^{-24}$ cm², in agreement with quadrupole resonance and microwave spectroscopy results. L. PINCHERLE

535.338.333

8136. On the isotope shift in the Nd I spectrum. G. NÖLDFKE AND A. STEUDEL. *Z. Phys.*, **137**, *No.* 5, 632–7 (1954) *In German.*

The hyperfine structure between 4600 and 5100 Å is investigated, and the isotope shift is determined for the mass numbers 142–150. A comparison with the isotope shift in Sm is discussed in relation to the jump in effect occurring at certain neutron numbers.

G. E. BROWN

535.338.333

8137. Spectroscopic isotope shifts and electron scattering by nuclei. W. R. HINDMARSH. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 393–4 (*April*, 1954).

535.338.333

8138. Isotope shifts in the atomic spectra of tin and cadmium. W. R. HINDMARSH, H. KUHN AND S. A. RAMSDEN. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 478–9 (*May*, 1954).

The shifts are measured for the range of mass numbers 112–124 for Sn and 110–116 for Cd.

G. E. BROWN

535.338.334

8139. Broadening of the inverse Zeeman components of the sodium *D*-line by the vapour pressure. J. TOMISER. *Acta phys. Austriaca*, **8**, *No.* 3, 276–84 (1954) *In German.*

As there exists a simple relation between the temperature and the vapour pressure, the influence of the latter could be investigated by measurements of the temperature and of the corresponding half-width of the Na *D*-line. This was carried out at vapour pressures between 0·032 and 0·429 mm Hg. It was found that the splitting of the line was regular in all photograms, but that the Zeeman components overlapped somewhat at higher pressures. The broadening varied linearly with the pressure. A. J. TAYLOR

535.34.07

8140. A simple method of making vacuum-tight coolable window seals for low temperature optical transmission cells. V. ROBERTS. *J. sci. Instrum.*, **31**, 251–2 (*July*, 1954).

A means of sealing various optical materials to copper or glass apparatus has been devised. The seals have been tested under high vacuum between room temperature and 20°K, and should be satisfactory at still lower temperatures. A.

535.34.07

8141. Spectrophotometric methods for determining the intensity, form, and width of infrared absorption bands of liquids. A. V. IOGANSEN. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 5, 919–22 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-215.*

An extension of previous work [Abstr. 3277 (1954)] showing how to determine the true absorption characteristics from the observations. The absorption at the max. of the band is determined for an infinitely narrow slit by an extrapolation which is shown to be valid. Deviations of the true form of a band from the assumed form $E(\nu) = E_0(1 + 4\nu^2)^{-1}$ may be evaluated, and by means of empirical equations the approximate corrections may be found to the observed values of band width and integral band absorption.

S. T. HENDERSON

535.343

8142. Infrared and ultraviolet absorption of various heterocyclic diaminosubstituted amines. M. M. STIMSON. *J. Phys. Radium*, **15**, 390–3 (*May*, 1954) *In French.*

535.343

8143. The absorption spectrum of thulium. L. F. H. BOVEY AND W. R. S. GARTON. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 476–7 (*May*, 1954).

Thulium oxide in a King furnace at 2400°C measured on a 3-metre Hilger spectrograph in the range 2500–6000 Å. A table of 85 lines is given. The temperature was not high enough for lines from the upper level ($^2F^0_{5/2}$). C. TURNER

535.343

8144. Theory of absorption spectra of catacondensed hydrocarbons according to Platt's circular model of free electrons. G. ARAKI AND T. MURAI. Letter in *J. chem. Phys.*, **22**, 954 (*May*, 1954).

The excitation energy for this model [Abstr. 3870 (1949)] is calculated, taking the interaction between π-electrons into account. Calculated values agree satisfactorily with experimental ones for a number of hydrocarbons. C. TURNER

535.343 : 539.132

8145. The intensity of certain absorption bands corresponding to the vibrations of the CH bonds. M. ST. C. FLETT. *J. Phys. Radium*, **15**, 388–90 (*May*, 1954) *In French.*

535.343 : 539.133

8146. The infrared absorption spectra and molecular structure of phenolphthalein, fluorescein and derivatives. M. DAVIES AND R. LUMLEY-JONES. *J. Phys. Radium*, **15**, 305–6 (*April*, 1954) *In French.*

The spectrum of fluorescein (*F*) supports the classical structure with a COO group. The spectra of Na and K salts of phenolphthalein (*P*) suggest a resonance structure; the spectra of the same salts of *F* indicate that the resonance is less complete. It is shown that *P*. KOH, H_2O and *P*. KOH, $2H_2O$ are addition compounds. G. F. LOTHIAN

535.343 : 541.124

8147. Pressure broadening in the spectrum of NO and its photodissociation. A. G. GAYDON AND A. R. FAIRBAIRN. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 474–6 (*May*, 1954).

Reports of abnormally large pressure broadening and induced predissociation in the γ-bands of NO are incorrect. In nitrogen at 1 atm the half-width of the NO lines is less than 0·025 Å. The photodissociation process is discussed. A. G. GAYDON

535.343–15

8148. Infrared spectra of some monoglycerides. J. R. BARCELÒ AND C. S. MARTIN. *J. Phys. Radium*, **15**, 403–5 (*May*, 1954) *In French.*

535.343–15

8149. Spectra of some simple molecules in the far infrared. A. HADNI. *J. Phys. Radium*, **15**, 417–18 (*May*, 1954) *In French.*

535.343–15 : 535.375.5 : 539.132

8150. The interpretation of the infra-red and Raman spectra of the *n*-paraffins. J. K. BROWN, N. SHEPPARD AND D. M. SIMPSON. *Phil. Trans A*, **247**, *No.* 922, 35–58 (1954).

Infrared spectra of a series of crystalline *n*-paraffins

containing an odd number of carbon atoms have been obtained. The spectrum of oriented crystals of *n*-nonadecane has also been examined. These new experimental results have been combined with the earlier data on the crystalline *n*-paraffins containing an even number of carbon atoms, and many series of absorption bands have been identified in the complete set of spectra. These regularities, as well as those present in the Raman spectra, have been interpreted in terms of CH_2, CH_3 and C—C stretching vibrations. Very regular distributions of frequencies have been found between 720 and 1030 cm^{-1} and between 1200 and ~1370 cm^{-1}, which are assigned to CH_2 rocking and wagging vibrations, respectively. The majority of the absorption bands between 1150 and 880 cm^{-1} can be attributed to C—C stretching or CH_3 rocking modes, and assignments are suggested for the principal series observed in this region. A.

535.343–15 : 539.133

8151. The infrared spectrum and the configuration of the molecule of formamide. J. C. EVANS. *J. Phys. Radium*, **15**, 314–15 (*April*, 1954) *In French.*

The spectra of formamide vapour, solution and liquid and of sodium formamidate and formamide hydrochloride have been examined from 2–15 μ. No association in the vapour was detected between 110 and 160°C, and between 10 and 155 mm partial vapour pressure. The contours of the absorption bands of the vapour indicate that the group HCON is coplanar, and that the NH_2 group is out of this plane but symmetrically placed with respect to it. The two valence modes of NH_2 (at 3545 and 3450 cm^{-1}) observed give rise to bands of type *B* and *C*.

A. J. TAYLOR

535.343–31

8152. Electronic spectra of nitrous oxide and nitric oxide under different states. J. GRANIER-MAYENCE, J. ROMAND AND S. ROBIN. *J. Phys. Radium*, **15**, 423–5 (*May*, 1954) *In French.*

535.343–31

8153. *s*-Triazine. II. The near ultra-violet absorption spectrum. R. C. HIRT, F. HALVERSON AND R. G. SCHMITT. Letter in *J. chem. Phys.*, **22**, 1148–9 (*June*, 1954).

For Pt I, see Abstr. 8798 (1954). Diagrams are given of this spectrum from 30 000 to 50 000 cm^{-1} in cyclohexane, acetonitrite, methanol and water solvents, and also the vapour spectrum. The band centred at 45 350 cm^{-1} in solution is assigned to the lowest singlet π–π transition ($^1A_1' - {}^1A_2''$). A value of −2·74 eV can be deduced for β_{CN}, the C–N resonance integral. The bands near 36 780 cm^{-1} must be due to an n–π transition. 2, 4, 6-trimethyl *s*-triazine has a similar spectrum. A. J. TAYLOR

535.343–32

8154. Absorption spectra of selenophene and *n*-methylpyrrole in the Schumann region. G. MILAZZO AND E. MIESCHER. *J. Phys. Radium*, **15**, 401–2 (*May*, 1954) *In French.*

535.343.2/.3–15

8155. Effect of temperature on the infrared absorption spectra of polyethylene, and rotational isomerism. I. I. NOVAK. *Zh. tekh. Fiz.*, **24**, *No.* 1, 18–24 (1954) *In Russian.*

Polyethylene and dicetyl have an absorption band at 1379 cm^{-1} in the crystalline state, and three additional ones, at 1340, 1350 and 1379 cm^{-1} in the liquid state, indicating rotational isomerism in the liquid state, confirmed by the presence in various liquid *n*-aliphatic hydrocarbons (*n*-butane, *n*-hexane, etc.) of two additional bands at 1341 and 1355 cm^{-1}, in addition to the 1378 cm^{-1} band characteristic of the solid state. From the variation of the absorption maxima in polyethylene with temperature, values of 720 ± 70 cal/mole (bands at 1370 and 1350 cm^{-1}) and of 640 ± 70 cal/mole (bands at 1379 and 1350 cm^{-1}) are found for the difference in energies of the rotational isomers, close to the value of 800 cal/mole calculated by Vol'kenshtein and Ptitsyn for the polyethylene macromolecule [*Uspekhi fiz. Nauk*, **49**, *No.* 4, 501 (1953)]. The band at 1370 cm^{-1} in polyethylene and dicetyl, absent in the normal hydrocarbons, indicates the presence of an amorphous phase. R. C. MURRAY

535.343.2

8156. Study of absorption lines of films of Cu_2O and HgI_2 at very low temperatures. S. NIKITINE, L. COUTURE, M. SIESKIND AND G. PERNY. *C.R. Acad. Sci.* [*Paris*] **238**, 1786–8 (*May* 3, 1954) *In French.*

Absorption bands of Cu_2O in the red and green move to shorter wavelengths as the temperature is reduced through the boiling points of N_2, H_2 and He. At the boiling point of H_2, HgI_2 shows an absorption line at 5298 Å and a band of continuous absorption at shorter wavelengths. G. F. LOTHIAN

535.343.2 : 537.371

8157. Effect of pressure on the optical absorption of the activator system in KCl : Tl. P. D. JOHNSON AND F. E. WILLIAMS. *Phys. Rev.*, **95**, 69–70 (*July* 1, 1954).

The optical absorption spectrum of thallium-activated potassium chloride has been measured at 2000 atmospheres. The absorption band corresponding to the $^1S_0 \rightarrow {}^3P_1^0$ transition of Tl^+ shifts 4 Å to longer wavelengths at this pressure. The spectral shift is calculated theoretically from the quantitative configuration co-ordinate model of KCl : Tl. The occupation probabilities of accessible atomic configurations of the activator system are dependent on pressure, whereas the transition energy for a particular configuration is independent of pressure. The pressure is considered to act hydrostatically on six pistons corresponding to the Cl^- nearest neighbours. The theoretical shift in absorption under 2000 atmospheres pressure is 5 Å to longer wavelengths. A.

535.343.2–15 : 541.14/.15

8158. Investigation at −186°C of the photochemically produced absorption in the near infrared (700–1100 mμ) of AgCl crystals containing Ag_2S. A. SCHOLZ. *Z. Phys.*, **137**, *No.* 2, 207–15 (1954) *In German.*

Crystals of AgCl containing 0·01 mole-% Ag_2S after irradiation at −186°C with light of wavelength 405 mμ show an absorption band (max. at 750 mμ) in the near infrared, which is stable at −186°C. The intensity of the band reaches a saturation value which is almost independent of the intensity of the (405 mμ) radiation. The number of absorption centres and therefore the (minimum) number of (presumed mainly Cl) vacancies is found to be 7×10^{16} per cm^3.

W. GOOD

535.343.2–15

8159. Polarized infrared spectrum of $KAu(CN)_2$: Revision and refinement. L. H. JONES. Letter in *J. chem. Phys.*, **22**, 1135 (*June*, 1954).

See Abstr. 1170 (1954). Further measurements indicate that the linear group N–C–Au–C–N is inclined at about 28° to the C axis of the crystal.

G. F. LOTHIAN

535.343.2–31 : 548.7

8160. New absorption bands for alkali halides with heavy metal additions. R. KAISER. *Z. Phys.*, **137**, *No.* 1, 104–12 (1954) *In German.*

Simultaneous condensation of silver and alkali metal from the vapour phase on to ten different halides produces new absorption bands in the ultraviolet with maxima and half-widths strongly temperature dependent and suggesting an atomically dispersed system. The band positions are unchanged by substitution of Cu or Tl for Ag and are characteristic of the matrix lattice. The new centres form more stable electron traps than halogen ion vacancies. G. F. J. GARLICK

535.343.32

8161. Polar solvent effects on the absorption spectra of metallic complexes. K. NAKAMOTO, M. KOBAYASHI AND R. TSUCHIDA. Letter in *J. chem. Phys.*, **22**, 957–8 (*May*, 1954).

Band shifts for solvent changes alcohol to water to acid are tabulated for about 20 compounds. The "first and second" bands shift to longer wavelengths and are ascribed to a π–π transition; the "specific bands" in general shift to shorter wavelengths and are ascribed to an n–π transition. G. F. LOTHIAN

535.343.32–15

8162. The infrared spectrum of pyrrole in solution. P. TUOMIKOSKI. *J. Phys. Radium*, **15**, 318–19 (*April*, 1954) *In French.*

Because of its well-known plane molecular structure and facility for forming hydrogen bands, pyrrole was chosen as test substance in an investigation of general rules of frequency shift with solvent dielectric constant (ε) for such bands as those of OH or NH valence vibrations. Spectra are given between 650 and 5000 cm^{-1}. For A_1 vibrations one would expect a decrease of force constant with increasing ε, but for B_1 and B_2 an increase. These effects are hidden by others in vibrations in which the NH group is unimportant. Therefore spectra have been taken of molecules with ND groups. Deuterization displaces the 1142 and 1048 cm^{-1} bands to 911 and 832 cm^{-1}, the position of the latter being independent of the solvent. The 1074 and 1013 cm^{-1} bands are unmoved. CO groups can influence other parts of the molecule besides NH groups. A. J. TAYLOR

535.343.32–15

8163. The effect of iodine on the infrared spectra of the alkyl iodides. R. H. SCHULER. Letter in *J. chem. Phys.*, **22**, 947 (*May*, 1954).

Solutions of iodine in ethyl and methyl iodide have been examined in cells of 0·1 mm path-length from 2–26 μ. The effects found on the spectra of the solvents are very small, in contrast to the great changes found in the visible and ultraviolet regions. There is a slight shift to longer wavelengths of the C–I stretching frequency. As with oxygenated donor molecules, solvation affects only the vibrational modes directly associated with the solvation.

A. J. TAYLOR

535.343.32–15

8164. Infrared absorption studies of aqueous complex ions: I. Cyanide complexes of Ag(I) and Au(I) in aqueous solution and adsorbed on anion resin. L. H. JONES AND R. A. PENNEMAN. *J. chem. Phys.*, **22**, 965–70 (*June*, 1954).

Techniques are described for obtaining infrared absorption spectra of complex cyanide anions in aqueous solution and adsorbed on anion resin. In the system $AuCN - KCN - H_2O$, only the soluble complex ion $Au(CN)_2^-$ is observed; the molar extinction coefficient (ε) is 477 $\pm$ 25 $mole^{-1}$ litre cm^{-1} at 2147 $\pm$ 1 cm^{-1}. When $Au(CN)_2^-$ is adsorbed to the extent of 47 weight % on Dowex-A-1 resin, its absorption maximum appears at 2138 cm^{-1}. Three distinct silver cyanide complex ions were observed in aqueous solution: $Ag(CN)_2^-$, $\varepsilon = 264 \pm 12$ at 2135 $\pm$ 1 cm^{-1}; $Ag(CN)_3^{-2}$, $\varepsilon = 397 \pm 23$ at 2105 $\pm$ 1 cm^{-1}; $Ag(CN)_4^{-3}$, $\varepsilon = 556 \pm 83$ at 2092 $\pm$ 1 cm^{-1}. Approximate values (calculated in terms of activities) of the dissociation constants for the tri- and tetracyanide complexes into the next lower complex are $K_{3,2} = 0{\cdot}20 \pm 0{\cdot}05$ mole $litre^{-1}$, and $K_{4,3} = 13{\cdot}4 \pm 4$ mole $litre^{-1}$, respectively. Over ranges of silver concentrations from 0·1–1·0 formal and of free CN^- ion concentrations from 0·05–1·5 molar, the concentrations of $Ag(CN)_2^-$, $Ag(CN)_3^{-2}$ and $Ag(CN)_4^{-3}$ can be calculated to within 5% (absolute) using values of the constants adjusted to best overall fit; in terms of concentrations, $K_{3,2}^c = 0{\cdot}108$ and $K_{4,3}^c = 2{\cdot}85$ mole $litre^{-1}$. A.

535.343.32–31

8165. Temperature dependence of the ultraviolet absorption spectrum of naphthalene in solution. R. PASSERINI AND I. G. ROSS. *J. chem. Phys.*, **22**, 1012–16 (*June*, 1954).

The absorption spectrum of naphthalene solutions has been measured, in the region 3300–2400 Å, at temperatures between +60°C and −185°C. Particular attention was given to the long-wavelength vibrational bands of the first electronic transition (3200–2900 Å), in order to locate and establish the identity of the band origin. The band acquires most of its intensity through the participation of an active vibration, whose ground-state frequency measured from two observed vibrational bands, is 525 $\pm$ 20 cm^{-1}, in adequate agreement with the value 544 $\pm$ 60 cm^{-1} found from the temperature dependence of intensity of the $0 \leftarrow 1$ band in this frequency. This is probably the Raman a_g frequency 512 cm^{-1}, which identification, in conjunction with previous polarization measurements, assigns the transition as $B_{2u} \leftarrow A_g$. Frequency and intensity data are given for 26 bands of this and the next transition (2900–2400 Å); the latter appears, vibrationally, to be allowed. A.

535.343.4

8166. Visible and ultraviolet absorption spectra of oxygen compressed up to 1 500 atmospheres. J. ROBIN AND S. ROBIN. *J. Phys. Radium*, **15**, 331–4 (*April*, 1954) *In French.*

Covers in slightly greater detail the same ground as a previous paper [Abstr. 6640 (1953)]. G. F. LOTHIAN

535.343.4–14

8167. Microwave spectrum of benzonitrile. G. Erlandsson. Letter in *J. chem. Phys.*, **22,** 1152 (*June*, 1954).

535.343.4–14 : 535.338.334

8168. Doppler line-width reduction. M. W. P. Strandberg and H. Dreicer. Letter in *Phys. Rev.*, **94,** 1393 (*June* 1, 1954).

The Doppler line-width of 72 kc/s for the (3,3) line of the NH_3 inversion spectrum at room temperature was reduced to 12 kc/s using a molecular beam transverse to the radiation. D. H. WHIFFEN

535.343.4–14 : 539.132

8169. Microwave spectrum and barrier to internal rotation of nitromethane. E. Tannenbaum, R. D. Johnson, R. J. Myers and W. D. Gwinn. Letter in *J. chem. Phys.*, **22,** 949 (*May*, 1954).

The $J_{1\to 2}$ set of lines are observed near 30 000 Mc/s and fitted to inertia parameters and a sixfold barrier restricting internal rotation with a height of $6{\cdot}00 \pm 0{\cdot}03$ cal/mole. D. H. WHIFFEN

535.343.4–14 : 539.133

8170. The microwave spectrum of fluorobenzene. K. E. McCulloh and C. F. Pollnow. Letter in *J. chem. Phys.*, **22,** 1144 (*June*, 1954).

The spectrum agrees with that of Erlandsson [Abstr. 5462 (1954)] but the accuracy of measurement is improved to 0·1 Mc/s. D. H. WHIFFEN

535.343.4–15

8171. The infrared spectrum of ketene. B. Bak and F. A. Andersen. *J. chem Phys.*, **22,** 1050–3 (*June*, 1954).

The infrared spectrum of gaseous ketene has been reinvestigated in the 500–1200 cm^{-1} region with a recording prism spectrophotometer using KBr and NaCl optics. Because of an experimental procedure which enabled the absorption of the impurities to be subtracted, a ketene absorption curve was obtained, probably more correct than that found by previous investigators. An interpretation of the numerous lines in the 500–1000 cm^{-1} interval is given, resulting in a reassignment of some of the fundamental vibrational frequencies. Thermodynamic functions are recalculated. A.

535.343.4–15

8172. An experimental study of band intensities in the first positive system of N_2. I. Vibrational transition probabilities. R. G. Turner and R. W. Nicholls. *Canad. J. Phys.*, **32,** 468–74 (*July*, 1954).

Integrated intensities of 52 bands of the N_2 first positive system have been measured using a recording infrared spectrometer. These data have been interpreted as vibrational transition probabilities which were compared with theoretical values calculated under the assumption that the electronic transition moment is independent of internuclear separation. The comparison shows that the assumption is not valid for this electronic transition. A.

535.343.4–15

8173. An experimental study of band intensities in the first positive system of N_2. II. The transition moment. R. G. Turner and R. W. Nicholls. *Canad. J. Phys.*, **32,** 475–9 (*July*, 1954).

Experimental band intensities of the first positive system ($B\,^3\Pi_g \to A\,^3\Sigma_u$) of nitrogen are used together with theoretical transition probabilities to determine the dependence of the electronic transition moment on the internuclear separation. Over the range $1{\cdot}17 < r < 1{\cdot}59$ Å of internuclear separation, this dependence may be represented by $R_e(r) = \text{const.} \times \exp(-3{\cdot}02\,r)$. A.

535.343.4–15 : 539.155.2

8174. A method of optical isotope analysis of some compounds. R. Fleischmann. *Z.Phys.*, **137,** *No.* 4, 516–19 (1954) *In German.*

The method described enables the ratio of Cl isotopes in gaseous HCl (and mixture ratios in some gases with similar absorption properties) to be determined. The method is based on the existence, in HCl, of an intensive absorption band between 3·3 and 3·8 μ, characterized by line pairs due to isotopes. This phenomenon is made use of in the infrared-absorption recording apparatus [see Pfund, *Science*, **90,** 326 (1939) and Luft, *Zeitschrift für technische Physik*, **44,** 98 (1943)]. The method is capable of a modification enabling the result to be directly read off on an indicating instrument. F. LACHMAN

535.343.4–32

8175. The absorption spectra of the gaseous monoxides of silicon, germanium and tin in the Schumann region. R. F. Barrow and H. C. Rowlinson. *Proc. Roy. Soc. A*, **224,** 374–88 (*July* 7, 1954).

The absorption spectra have been examined in the region 1250 to 2000 Å. A number of new band systems have been found, and vibrational analyses have been carried out. The determination of the dissociation energies of these molecules is discussed: the values derived spectroscopically for SiO, GeO and SnO are $185{\cdot}_0 \pm 6{\cdot}_8$, $155{\cdot}_8 \pm 5{\cdot}_3$ and $126{\cdot}_0 \pm 4{\cdot}_9$ kcal (0°K) respectively. The values for GeO and SnO are in satisfactory agreement with the results of thermochemical work, but the result for SiO suggests that the value of the latent heat of sublimation of silicon is higher than has been suggested, and indicates $L_{Si} \simeq 100$ kcal. The correlation between the states of carbon monoxide and of silicon monoxide is briefly considered, and a provisional value for the ionization potential of SiO, $10{\cdot}5_1$ eV, is derived. A.

535.343.9

8176. Absorption spectra of samarium benzoylacetonate. E. V. Anufrieva and A. N. Zaĭdel'. *Zh. éksper. teor. Fiz.*, **24,** *No.* 1, 114–16 (1953) *In Russian.*

Contrary to the results of A. N. Sevchenko and A. K. Trofimov [Abstr. 6881 (1951)] and A. N. Sevchenko and A. G. Morachevskiĭ [*Izv. Akad. Nauk SSSR, Ser. fiz.*, **15,** 628 (1951)], the absorption spectrum of $Sm(C_{10}H_9O_2)_3$ displays a discrete structure. F. LACHMAN

535.345

8177. Light absorption of solid ammonia layers with alkali metal addition. E. Bosch. *Z. Phys.*, **137,** *No.* 1, 89–103 (1954) *In German.*

By condensation at 90 and at 20°K thin layers of ammonia with addition of Na, K or Li are made. At 20°K an absorption band occurs at $1{\cdot}15\,\mu$ which is independent of the particular alkali metal used and is probably due to electron states in solid ammonia to which electrons are supplied from the alkali metal.

Other bands also occur characteristic of the particular metal and ascribed to neutral atoms or colloidal specks at boundaries. The bands are shifted by annealing. The layers showed very high electrical resistance and show no superconductivity at the above temperatures. G. F. J. GARLICK

535.345 : 537.311.33

8178. The optical absorption constant of cadmium oxide. J. STUKE. *Z. Phys.*, **137**, *No.* 4, 401–15 (1954) *In German.*

The position of the absorption edge of CdO at room temperature shows a marked dependence on the method of preparation and previous treatment of the material. Good agreement is shown between the edge position and conductivity and the edge shifts to longer wavelengths with rising temperature as for other semiconductors. G. F. J. GARLICK

535.345 : 537.312.62

8179. The optical constants of tin below the superconducting transition temperature. N. G. MCCRUM AND C. A. SHIFFMAN. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 386–8 (*April*, 1954).

Measurements are described using plane-polarized light upon a thin film of tin. The film thickness is 1900 Å, measured by multiple beam interference. Measurements were made by switching on and off a large magnetic field, whilst observing the position of the balance with a nicol. The experiments indicate that in a transition from the superconducting to the normal state any change in the absorption coefficient at 5890 Å is less than 0·3%, the experimental limit of accuracy. S. TOLANSKY

535.345–15

8180. On an absorption band of fused silica in the infrared. V. GARINO-CANINA. *Cahiers de Phys.*, *No.* 48, 72–6 (*March*, 1954) *In French.*

If fused silica is prepared in various ways, only those samples in which water vapour is present during fusion show an absorption band at 2·7 μ. This is attributed to the presence of Si–O–H groups.

G. F. LOTHIAN

535.345–15

8181. Beer's law applied to absorption spectra in the infrared. J.-C. PARIAUD. *C.R. Acad. Sci.* [*Paris*] **238**, 1649–51 (*April* 21, 1954) *In French.*

In certain cases departures from Beer's law may be attributed to ionization or to hydrogen bonding.

G. F. LOTHIAN

535.37

8182. Luminescence of inorganic phosphors. G. F. J. GARLICK. *Nature* [*London*] **173**, 1077–8 (*June* 5, 1954).

Report of a conference held at the Cavendish Laboratory, Cambridge, during April 7–10, 1954, organized by the Electronics Group of the Institute of Physics.

535.371

8183. The manganese emission in ABF_3 compounds. H. A. KLASENS, P. ZALM AND F. O. HUYSMAN. *Philips Res. Rep.*, **8**, 441–51 (*Dec.*, 1953).

A number of compounds of the composition ABF_3 were made with A = Na, K, Rb, Cs and B = Mg, Zn, Cd, Ca, Sr. These substances have the perovskite structure when the corrected tolerance factor, $[1\cdot09\,(R_A + R_F)] \div [0\cdot94\,(R_B + R_F)\sqrt{2}]$, lies between 0·9 and 1·1. They are fluorescent under cathode-ray excitation when activated with Mn. The colour of the Mn emission varies between orange and green. It shifts to shorter wavelengths with increasing Mn–F distance. An attempt is made to explain this shift. A.

535.371

8184. The luminescence of silver-activated rock salt. W. HANLE AND H. HINRICHS. *Z. angew Phys.*, **6**, 201–3 (*May*, 1954) *In German.*

The luminescence and scintillation characteristics of NaCl phosphors with three different silver concentrations are investigated inclusive of fluorescence, phosphorescence stimulation, thermo-luminescence, radiophotoluminescence and the change of characteristics under electron bombardment.

G. F. J. GARLICK

535.371

8185. On the quenching of fluorescein fluorescence. A. SCHMILLEN. *Z. angew. Phys.*, **6**, 260–2 (*June*, 1954) *In German.*

Studies of quenching of fluorescence of fluorescein in H_2O and CH_3OH by phenol, hydroquinone or acridin impurity show that for phenol and hydroquinone a "static" quenching process occurs, for acridin the quenching process is of the "dynamic" kind. G. F. J. GARLICK

535.371

8186. Comparison of luminescence and exo-electron emission. J. KRAMER. Note in *Naturwissenschaften*, **41**, *No.* 7, 160–1 (1954) *In German.*

535.371

8187. On the fluorescence of cadmium iodide. S. SCHLIVITCH AND G. MONOD-HERZEN. *C.R. Acad. Sci.* [*Paris*] **238**, 2071 (*May* 24, 1954) *In French.*

See Abstr. 917 (1952). Luminescence occurs at cadmium iodide–lead iodide crystal boundaries and irregularly within the volume of the cadmium iodide on crystallization from solution. Luminescent products result from fusion of the anhydrous salts in which emission is distributed through the crystal mass. G. F. J. GARLICK

535.371

8188. Configuration coordinate model for luminescence in KCl : Tl. P. D. JOHNSON. Letter in *J. chem. Phys.*, **22**, 1143 (*June*, 1954).

The theoretical method of Johnson and Williams [Abstr. 2633 (1952)] for determining the potential energy configuration of the $^1S_0$ or $^3P_1^0$ state of Tl^+ centres in KCl is extended to other states particularly for the transition $^1S_0 \leftrightarrow {}^1P_1^0$. G. F. J. GARLICK

535.371

8189. The quenching of the fluorescence of anthracene. The transition from strong to weak quenching. H. W. MELHUISH AND W. S. METCALF. *J. Chem. Soc.*, **1954**, 976–9 (*March*).

Quenching of fluorescence in solution occurs when quencher molecules and excited molecules occupy contiguous positions in a liquid. Strong quenchers are limited by the viscosity-controlled rate of formation of neighbouring pairs, while weak quenchers are limited by the concentration of such pairs and the efficiency of collisions within them. An equation is

derived from this model which describes the observed behaviour of quenchers of intermediate strength. A photometer is described which is suitable for the precise measurement of relative fluorescence intensities. A.

535.371

8190. Cascade excitation of phosphors by ultraviolet radiation. P. W. RANBY AND S. T. HENDERSON. Letter in *Proc. Phys. Soc.* [*London*] *B*, **67**, 496–7 (*June*, 1954).

Ca aluminate activated by Tl has a feeble yellow fluorescence to short or long ultraviolet radiation, but a much brighter response if exposure to 2537 Å is followed by 3650 Å, even with several days' interval between. The effects partly resemble those of radiophotoluminescence, and partly those of infrared stimulation. S. T. HENDERSON

535.371

8191. Energy transfer in organic phosphors. J. B. BIRKS. *Phys. Rev.*, **94**, 1567–73 (*June* 15, 1954).

A quantitative theory is developed of the photofluorescence and scintillation properties of organic materials. On this theory the intermolecular energy transfer occurs by photon emission and absorption; the molecular emission spectrum extends continuously from the ionization energy E_I down to the strong fluorescence band normally observed; the emission of primary photons $\sim E_I$ is excited by ionizing radiations; and the subsequent scintillation process consists of a photon cascade, through the emission spectrum. The theory is in agreement with the experimental data on the photofluorescence and scintillations from pure and mixed crystals, and on the scintillations from solutions. It is shown that, because of self-absorption, many of the existing data refer only to the technical fluorescence properties, and a preliminary assessment is made of the molecular properties of the more important organic phosphors. A.

535.371 : 541.14

Radiation chemistry of luminescent solutions. *See Abstr.* 8735

535.371.07 : 537.533.35 : 621.385.833

8192. Comparative measurements on electron-excited viewing screens in transmission and reflection. B. DEUBNER AND F. HIEBER. *Z. angew. Phys.*, **6**, *No.* 3, 112–15 (1954) *In German.*

The light output, in dependence on thickness of luminescent layer, was measured for several types of screens viewed either in transmission or directly from the side of the incident electron beam. The screen material was Cu-activated ZnS, the electrons were provided by an AEG electron microscope operated at 40 kV and the measurements were made with a photocell and galvanometer. With front-viewed screens, the light output increased with screen thickness towards a saturation value. In transmission viewing the output was very much less, even with a reflecting layer of Al on the bombarded side, unless this layer was separated from the screen material by a collodion film, in which case the output was only some 10% less than for front viewing. There is an optimum thickness for the Al layer. The resolving power of the screens was measured from the unsharpness of the image of an opaque straight edge. It varied little with thickness or graininess of screen material for a given method of viewing, but was poorer by 60% in transmission as compared with front viewing. Estimation of resolving power for images of small particles of moderate contrast indicated that it was 100% poorer than for black-white contrast, and more sensitive to grain size, in agreement with earlier work of v. Borries [Abstr. 1470 (1949)]. V. E. COSSLETT

535.372

8193. Phosphors emitting infra-red radiation. G. F. J. GARLICK AND M. J. DUMBLETON. Letter in *Proc. Phys. Soc.* [*London*] *B*, **67**, 442–3 (*May*, 1954).

The infrared emission spectra of new and already known phosphors in the region 1–3·5 μ are described. New phosphors include CdSe–Cu (1·2 μ), CdS–HgS–Cu (1–1·75 μ), HgS (2·1 μ) and ZnS–Co (3·2 μ). The 2·6 μ band of PbS at 290°K moves to 3·3 μ at 90°K and the 2·1 μ band for HgS at 290°K to 2·45 μ at 90°K. G. F. J. GARLICK

535.372

8194. The measurement of spectral distributions of luminescent materials above room temperature. A. LANGRIDGE AND M. P. LORD. Letter in *Brit. J. appl. Phys.*, **5**, 196 (*May*, 1954).

535.372

8195. Polarization of the fluorescence of some organic single crystals. P. PESTEIL. *J. Phys. Radium*, **15**, 407–9 (*May*, 1954) *In French.*

535.375.5

8196. Low frequency Raman spectrum of hydrated aluminium chloride. G. CHAMPIER AND A. GALY. *C.R. Acad. Sci.* [*Paris*] **238**, 1708–10 (*April* 26, 1954) *In French.*

The Raman spectrum of hydrated $AlCl_3$ has been taken from about 70 to 820 cm^{-1}; the lines below 308 cm^{-1} are intense and narrow, those above are weak and of breadth about 30 cm^{-1}. On the assumption that translation-pivoting frequencies are absent, one finds that there are four A_g and nine E_g translation frequencies (which are <300 cm^{-1}) and three E_g pivoting (of the water molecules) frequencies above 300 cm^{-1}. Constants have been calculated for a quadratic potential function which accounts for the translation frequencies. It appears that the water molecules pivot about their principal axes of inertia. A. J. TAYLOR

535.375.5

8197. Raman spectra and structures of some inorganic compounds containing NO_2^+ or NO^+ ions. H. GERDING, K. ERIKS, P. M. HEERTJES, H. HOUTGRAAF, L. J. REVALLIER AND J. W. M. STEEMAN. *J. Phys. Radium*, **15**, 406–7 (*May*, 1954) *In French.*

535.375.56

8198. High resolution Raman spectroscopy of gases. II. Rotational spectra of C_6H_6 and C_6D_6, and internuclear distances in the benzene molecule. B. P. STOICHEFF. *Canad. J. Phys.*, **32**, 339–46 (*May*, 1954).

For Pt I, see Abstr. 6518 (1954). The pure rotational Raman spectra of benzene and benzene-d_6 at a pressure of $\frac{1}{2}$ atm. were photographed in the second order of a 21 ft grating. Both spectra were resolved and analysed, yielding for the rotational constants the values $B_0(C_6H_6) = 0{\cdot}189\,60 \pm 0{\cdot}000\,05$ cm^{-1}, $B_0(C_6D_6) = 0{\cdot}156\,81 \pm 0{\cdot}000\,08$ cm^{-1} and, therefore,

for the moments of inertia about an axis perpendicular to the figure axis, $I_B^0(C_6H_6) = (147{\cdot}59 \pm 0{\cdot}04) \times 10^{-40}$ g. cm^2, and $I_B^0(C_6D_6) = (178{\cdot}45 \pm 0{\cdot}09) \times 10^{-40}$ g. cm^2. If it is assumed that the benzene molecule has the planar hexagonal structure, the moments of inertia just given yield for the internuclear distances in benzene the values r_0(C–C) $= 1{\cdot}397_3 \pm 0{\cdot}001$ Å and r_0(C–H) $= 1{\cdot}084 \pm 0{\cdot}006$ Å. A.

535.376

8199. The luminescence mechanism of the X-ray excited KCl–Tl phosphor. I. A. PARFIANOVICH. *Zh. éksper. teor. Fiz.*, **24**, *No.* 1, 117–23 (1953) *In Russian.*

The phosphor used was obtained as described in the paper of V. V. Antonov-Romanovskiĭ [*Trudy FIAN*, 2–3, 157 (1942)]. The X-ray tube used for excitation had the following characteristics: 58 kV, 6 milliamp, the time of excitation being within the range 1–20 min. Results of experiments point to the existence of three systems of trap levels on which the electrons which store the light energy are localized. It has been shown that the phosphorescence levels are sensitive to infrared radiation, and that there exists a temperature quenching of luminescence. The results are used for constructing the probable kinetics of the luminescence of the phosphor; a proof is supplied for the recombination nature of this luminescence.

F. LACHMAN

535.376

8200. Search for *F*-center luminescence. C. C. KLICK. *Phys. Rev.*, **94**, 1541–5 (*June* 15, 1954).

Measurements have been made on the quantum efficiency of luminescence from *F*-centres in X-rayed LiF and additively coloured KCl at 4°K. In the wavelength range from 3000 Å to 20 000 Å an upper limit of 3% efficiency is found for the LiF *F*-band emission, if it exists. At 25 000 Å the upper limit is 10%. Similar results are found for *F*-centres in KCl in the wavelength range from 6500 Å to 25 000 Å. These results are in disagreement with theoretical predictions that the *F*-centre should luminesce with high efficiency in the wavelength region near 10 000 Å. A.

535.376

8201. Temperature dependence of organic scintillation materials. J. B. BIRKS. Letter in *Phys. Rev.*, **95**, 277 (*July* 1, 1954).

535.39 : 535.51

8202. A new gloss meter incorporating a method for accurately measuring the polarization of light. L. F. HOPKINS AND A. P. HIGHTON. Letter in *Nature* [*London*] **173**, 1088 (*June* 5, 1954).

A narrow beam of light is partially polarized by reflection from the paper under test. An optical arrangement is briefly described by which this reflected beam is polarized alternately in two directions at right angles and has its intensity modulated. The beam then passes through an analyser on to a photoelectric cell, the output of which is amplified and recorded on a meter. The analyser position which gives the minimum meter reading is noted: it is a measure of the gloss. The results are reproducible to within 0·25° with untrained observers. The instrument is not accurate for very high gloss surfaces. Further details are to be published later.

H. G. JERRARD

535.393

8203. Reflection from a mirror surface with an absorbent coating. J. R. WAIT, K. F. HILL AND W. A. POPE. *J. Opt. Soc. Amer.*, **44**, 438–41 (*June*, 1954).

The problem of a plane-wave incident obliquely on a layer of absorbent (dissipative) material uniformly coated on a mirror (highly conducting) plane surface is considered. The results of extensive numerical calculations, carried out for a wide range of values of the parameters, are reported. Approximate formulae for the reflection coefficients to supplement these calculations are derived for the case when the "absorption" in the layer is small. A.

535.41 : 537.525.8

8204. Optical method of determining the concentration of atoms and molecules in the ground state. A. M. SHUKHTIN. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 3, 553–5 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-201.

The method consists in determining the change in the concentration of the absorbing particles in the given layer of the substance by observing only the interference pattern in Rozhdestvensky's "Hacken-Methode" layout and measuring the linear dimensions of the compensator (or the density of the substance in the compensator). The method has been used to determine the concentration of normal Cs atoms in the positive column of a discharge, and good agreement has been obtained with results obtained by the "Hacken-Methode." The accuracy and merits of both methods are discussed. F. LACHMAN

535.412 : 535.316

8205. Image forming properties of zone lenses. C. v. FRAGSTEIN AND K. WEBER. *Optik*, **11**, *No.* 6, 270–81 (1954) *In German.*

Measurements of the focal lengths in different orders and the variation with wavelength are shown to agree with the theory of zone plates. The resolving power, field curvature, astigmatism and distortion are also investigated. A comparison between a zone plate and a microscope objective shows that the former is only inferior in resolving power by a factor of 4. R. W. FISH

535.415

8206. Newton's rings of high visibility. D. A. RICHARDS. Note in *Proc. Phys. Soc.* [*London*] *B*, **67**, 492–4 (*June*, 1954).

With the conventional arrangement for the determination of the refractive index of a liquid by Newton's rings formed by a lens surface and an optical flat, difficulty is experienced due to a lack of contrast between the rings and the background. A beam-splitter cube is used for illumination to eradicate unwanted reflections and increase contrast. R. W. FISH

535.417

8207. A unicentric zone plate. V. A. ZAMKOV. Letter in *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 367–8 (1953) *In Russian.*

A unicentric reflection-type zone plate is described, the zones of which are spherical elements with radii forming arithmetical progression $R + nd$, where d, the height of the step, is equal to ½ the wavelength of incident light. Properties of this zone plate are discussed.

F. LACHMAN

535.417

8208. The visibility of interference using the Twyman interferometer. G. HANSEN. *Z. angew. Phys.*, **6**, 203–5 (*May*, 1954) *In German.*

The aperture conditions necessary for the production of high contrast when using the Twyman interferometer for the examination of lens systems is discussed. The radius of curvature of the concave or convex mirror used with the interferometer for lens examination influences the size of the aperture employed. An upper limit to the aperture is defined, aperture diameters exceeding this leading to reduction in visibility. An exact analysis is given for convex lenses and for Kepler telescopes tested in the interferometer. S. TOLANSKY

535.417

8209. Interferometric methods employing fringes of superposition. M. CAGNET. *Rev. Opt.*, **33**, 1–25 (*Jan.*); 113–24 (*Feb.–March*); 229–41 (*May*, 1954) *In French.*

The theory of Brewster's fringes is developed in detail especially for the case of multiple beams secured by the deposition of high reflecting surfaces either of silver or multilayers. The sensitivity of the system for the interferometric examination of thin objects is discussed in detail and the effect of the source width and source chromatism is analysed. Comparison is made with multiple-beam Fizeau fringes. Auto-compensating devices are described and a practical interferometer is developed. A method is described for measuring phase change introduced by thin films and experimental data are reported for deposition on glass. Self-compensating interferometers are described and are suitable for studying homogeneity of transparent materials, such as defects in glass. S. TOLANSKY

535.417

8210. Multilayer dielectric reflecting films at wavelengths between 4000 and 4600 Å. J. RING AND W. L. WILCOCK. Letter in *Nature* [*London*] **173**, 994 (*May* 22, 1954).

It is shown that phase variation with wavelength affects the calculated values for reflection, transmission, and absorption coefficients for multilayer films used in the production of interference filters. New values are given for the region 4100–4500 Å. S. TOLANSKY

535.417

8211. The wave-band filter, an interference filter of very high efficiency. W. GEFFCKEN. *Z. angew. Phys.*, **6**, 249–50 (*June*, 1954) *In German.*

A brief discussion of transmission and band-width of simple interference filters. The properties of two identical filters in series are discussed. It is shown that a filter of tenth-width as low as 1·5, can be secured. This tenth-width can be produced by a compound filter consisting of two dielectric layers between three metal films. Two such filters in series are extremely efficient. The background is not detectable. Tenth-widths of the order 25–50 μ are reported. S. TOLANSKY

535.42

8212. The measurement of Fresnel diffraction phenomena with wide slits. H. BURKHARDT. *Z. Phys.*, **138**, *No.* 1, 89–92 (1954) *In German.*

An experimental determination of diffraction phenomena with slits 1 mm wide. The diffraction fringes are normally so weak that it is in general difficult to measure their intensities accurately. This has been done here by the use of a sensitive multiplier cell. An accuracy of 0·1% is claimed. Deviations between theory and experiment are 2·5%, but reach 10% on the geometric shadow border. Effects are independent of wavelength and polarization. The observed deviation is attributed to the difficulty of making exact calculations. S. TOLANSKY

535.43 : 548.7

8213. Theory of the scattering of light by a cubic crystal. J. BARRIOL AND J. CHAPELLE. *J. Phys. Radium*, **15**, 334–6 (*April*, 1954) *In French.*

Develops the theory of the anti-Stokes scattering of an e.m. wave by an isotropic crystal subject to thermal elastic waves. The λ^{-4} law of scattered intensity is deduced. G. F. LOTHIAN

535.434

8214. Light scattering of spherical colloidal particles. W. HELLER AND W. J. PANGONIS. Letter in *J. chem. Phys.*, **22**, 948–9 (*May*, 1954).

Values of specific turbidity calculated from Mie theory are tabulated for $2\pi r/\lambda = 0{\cdot}2$–$7{\cdot}0$ and for relative refractive index 1·05–1·30. G. F. LOTHIAN

535.434 : 771.53

8215. Scattering of light by crystals of photographic emulsions. P. KH. PRUSS. *Zh. tekh. Fiz.*, **24**, *No.* 1, 50–9 (1954) *In Russian.*

The results of investigations on the relationship between the scattering of light by an undeveloped photographic emulsion and the concentration of the Ag halide in the emulsion show that the weakening of the feebly absorbed light flux, due to the scattering in an emulsion poor in Ag halide, obeys Bouguer's law. The dependence of the coefficient of scattering on crystal size was investigated for thin layers of AgBr emulsions synthesized by the NH_3 method, and also for the AgBr crystals of the ammonia emulsions. For $\lambda = 0{\cdot}55\ \mu$, the coefficient of scattering of the layer attains its maximum with the mean size of emulsion crystals $\sim 0{\cdot}3\ \mu^2$, while that of the crystals, at the mean size $\sim 0{\cdot}4\ \mu^2$. The experimental curve showing the dependence of the coefficient of scattering for emulsion crystals on their size agrees well with the theoretical curve. F. LACHMAN

535.435 : 535.51 : 532.7

8216. Scattering of light and the orientation order in liquids. M. F. VUKS. *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 351–8 (1953) *In Russian.*

See Abstr. 3188 (1953). A table is compiled, giving, *inter alia*, the optical anisotropy (γ^2) of the vapour molecules and the effective optical anisotropy (γ^2_{eff}) of the liquid molecules for: C_6H_6, C_6H_5OH, C_6H_5Cl, C_6H_5Br, $CHCl_3$, $CHBr_3$, p–$C_6H_4Cl_2$, $C_{10}H_8$, $C_6H_5NO_2$, CH_3COOH, $(CH_2)_6$ and H_2O. It has been confirmed that the optical anisotropy varies little when the substance passes from the gaseous into liquid state. The apparent anisotropy changes should be attributed to the existence of a short-range order. For some liquids (i), $\gamma^2_{\text{eff}} < \gamma^2$, for others (ii), $\gamma^2_{\text{eff}} > \gamma^2$. For (i) the intensity of anisotropic scattering increases together with temperature, provided $\gamma^2_{\text{eff}} \ll \gamma^2$; for (ii) the intensity of anisotropic scattering falls rapidly off as temperature increases. F. LACHMAN

535.55 : 666.1.037.5

8217. Testing glass-metal seals in polarized light. H. HERRMANN. *Glas- u. Hochvakuumtechnik*, **2**, *No.* 10 (1953) [Reprinted in *Entwicklungsber. Siemens u. Halske*, **16**, *No.* 4, 439–50 (1953)] *In German.*

The principles of stress determination in glass-metal seals using the polariscope are discussed. The theoretical results due to Hull and Berger and Poritsky are compared with experimental findings on various combinations of sealing alloy and glass. The main conclusion is that the theoretical finding that the axial tension at the metal/glass interface, in a bead seal, decreases with increasing ratio of overall seal thickness to thickness of metal is confirmed, while the constancy of axial tension over the glass depends on the length of bead and is only true for long beads. In seals to sheet alloy the stresses increase with increasing sheet thickness up to 1 mm and then remain constant for thicknesses up to 3 mm. A. H. W. BECK

535.681 : 535.89

8218. Colour rendering of fluorescent lamps. M. ARTOM AND C. GENTILE. *Elettrotecnica*, **41**, 215–20 (*April*, 1954) *In Italian.*

After a critical description of the various methods proposed for expressing the colour rendering properties of a source, with particular reference to that of C. W. Jerome and D. B. Judd [Abstr. 6679 (1953)], the authors apply a simplified modification of this method to a Planckian radiator at 4500°K and a cool white fluorescent lamp, each illuminating three selected coloured surfaces. They find that the method gives results which do not greatly differ from those obtained by the more rigorous procedure. A figure of merit for colour rendering properties is suggested. J. W. T. WALSH

535.7 : 612.84

Physiological optics. *See Abstr.* 8816–18

535.822

8219. Photomicrography with a Kellner eyepiece. F. SMITHSON. Letter in *Nature* [*London*] **173**, 1047–8 (*May* 29, 1954).

A small photographic plate is supported on the stop in the eyepiece used for holding a micrometer in the image plane. Some practical details are given and sample photomicrographs of mineral grains are shown. R. W. FISH

535.822 : 530.162

Information theory and uncertainty principle. *See Abstr.* 8072

535.823.5 : 531.131.2

Parasitic vertical movement of a symmetrical system of guided rods. *See Abstr.* 8075

HEAT 536

536.2 : 533.7

Effect of specular reflection on gaskinetic heat transmission and friction. *See Abstr.* 8102

536.2.01

8220. On a functional equation of heat conduction. H. WUNDT. Note in *Z. angew. Math. Phys.*, **5**, *No.* 2, 172–5 (1954) *In German.*

The equation $\Delta t_m = (\Delta t_1 - \Delta t_2)/ln(\Delta t_1/\Delta t_2)$ is expressed as a functional equation $2f[(x-y)/ln(x/y)] = f(x) - f(y)$ and is solved analytically to give the logarithmic mean temperature difference. The continuous solutions are briefly discussed. E. H. DOCK

536.2.08

8221. On the application of Ångström's method of measuring thermal conductivity. C. H. BOSANQUET AND R. ARIS. *Brit. J. appl. Phys.*, **5**, 252–5 (*July*, 1954).

Ångström's well-known method of measuring thermal conductivity by the steady periodic motion of heat along a bar has a very elegant and simple theory. Its application, however, suffers from the fact that the theory makes use of the first Fourier component of the heat wave. By standardizing the heat input to a rectangular waveform and using the method of calculation here described, accurate results can be obtained without having recourse to a Fourier analysis. A.

536.2

8222. An instance in thermal convection of Eddington's "overstability." D. FULTZ, Y. NAKAGAWA AND P. FRENZEN. *Phys. Rev.*, **94**, 1471–2 (*June* 15, 1954).

The existence of modes of cellular convection driven by thermal instability which are oscillatory in type rather than steady, has been predicted theoretically for systems that are rotating as a whole. Such modes are of a type called "overstable" by Eddington in a different connection. The result of an initial successful experiment with mercury is given. A.

536.413 : 541.183

The expansion of porous glass on the adsorption of non-polar gases. *See Abstr.* 8741

536.413.2 : 548.736.1 ; 537.311

Expansion coefficient and density of plutonium metal. *See Abstr.* 8263

536.42 : 536.71

Helium and the range of stability of the solid state. *See Abstr.* 8246

536.421 : 536.5.08

8223. Reproducibility of the freezing temperature of high-purity zinc. E. H. MCLAREN. Letter in *J. appl. Phys.*, **25**, 808 (*June*, 1954).

It has been shown that the freezing point of high purity Zn is 419·5°C with an average deviation between different samples of 2×10^{-4}°C and a pressure variation less than 10^{-4} deg per cm Hg. It is suggested that this temperature would be a more suitable fixed point on the International Temperature Scale than the present sulphur point. E. H. DOCK

536.421.1

8224. A variant of the Leiden frost phenomenon. E. REGENER. *Z. Naturforsch.*, **9a**, 276–8 (*April*, 1954) *In German.*

It is possible to heat the bottom of an air-free glass vessel containing ice without melting the ice. A simple method of demonstration is described. L. G. CARPENTER.

536.421.1

8225. $BaTiO_3$–KF phase diagram. C. KARAN. Letter in *J. chem. Phys.*, **22**, 957 (*May*, 1954).

Attention is drawn to too low liquidus temperatures obtained [Abstr. 3368 (1954)] on the $BaTiO_3$-rich side of the eutectic composition. Interim values, as determined from solubility measurements, are given. W. GOOD

536.421.1

8226. Solid ozone. C. BROWN, W. BERGER AND K. HERSH. Letter in *J. chem. Phys.*, **22**, 1151–2 (*June*, 1954).

The melting point of ozone, using the blocked tube method, was found to be $-193 \pm 0{\cdot}5$°C, as against the hitherto accepted value of $-251{\cdot}4$°C. It supercools readily and is normally fluid at —195°C.

T. P. BRODY

536.423.4

8227. Condensation of water vapour on solid paraffin. A. BRIN. *C.R. Acad. Sci.* [*Paris*] **238**, 1124–5 (*March* 8, 1954) *In French.*

If a paraffin surface at θ_1° is suddenly placed in contact with vapour saturated at θ_2°, a definite superficial density of condensed drops results. A plot of drop density against θ_2 for three values of θ_1 is given, and interpreted as showing the existence of two types of condensation nuclei on the surface.

L. G. CARPENTER

536.423.4

8228. The theory of condensation, equilibrium of vapour in the presence of drops. Y. ROCARD. *C.R. Acad. Sci.* [*Paris*] **238**, 1198–1200 (*March* 15, 1954) *In French.*

Let p_2 be the pressure of vapour which is in (unstable) equilibrium with a drop of given radius and p_1 be the pressure inside the drop. Then p_1–p_2 is fixed by the surface tension and the absolute values of p_1 and p_2 are determined by $\int_{p_1}^{p_2} v\,dp = 0$. The classical treatment takes $v_2 \gg v_1$ but the integral can be evaluated directly when a continuous isotherm (such as that of Van der Waals) is assumed. In this way explicit expressions are found for behaviour in the critical region.

R. O. DAVIES

536.453

8229. Aspects of the design of solar furnaces for high temperature research and development. W. M. CONN. *Z. angew. Phys.*, **6**, 284–91 (*June*, 1954) *In German.*

After a brief examination of the literature various parts of the equipment are considered in detail. Various mirror set-ups are illustrated and described and ten plants are compared in tabular form for type and size of units.

E. H. DOCK

536.46

8230. Determination of the distribution of some parameters across the combustion zone of a flat flame. J. H. BURGOYNE AND F. J. WEINBERG. *Proc. Roy. Soc. A*, **224**, 286–308 (*July* 7, 1954).

A method has been developed for recording the variation of temperature through a plane flame as a means of analysing the distribution of other variables. The method, which depends on refractive index gradient measurement, combined with an accurate observation of the initial temperature, is illustrated by results obtained with a very lean ethylene/air mixture. From the temperature distribution, together with a simultaneously measured value of the burning velocity and known physical properties of the gases, variations of other parameters through the flame are calculated.

A.

536.461

8231. Measurement of the flame speed in mixtures of air with liquid fuel. J. RAPPENEAU. *C.R. Acad. Sci.* [*Paris*] **238**, 1192–4 (*March* 15, 1954) *In French.*

Flame speeds in mixtures of air (at 150°c) with atomized kerosine, measured by the usual method from photographs of the blue cone on a suitable burner, are fitted by the empirical equation $V_t = 0{\cdot}2677\ V_l R^{0{\cdot}262}$ in which V_l, V_t are the flame speeds for laminar ($R < 3000$) and turbulent (R 3000–7000) flow: the air/fuel ratio was varied between 10 and 17. Measurements of flame temperature at the tip of the cone, by sodium-line reversal, agree well with calculated values.

R. C. MURRAY

536.462

8232. Temperature measurements in rocket exhausts. F. RÖSSLER. *Z. angew. Phys.*, **6**, 229–31 (*May*, 1954) *In German.*

The temperature in the exhaust from a rocket burning SD 21 cordite, measured by a modified line reversal method, increases linearly with distance from the orifice to a max. of 2050°K, presumably due to secondary combustion of CO and H_2 in the exhaust gases with air entrained by turbulence. Since the theoretical temperature for combustion of a stoichiometric mixture with air would be 2700°K, excess air must be entrained. Backward extrapolation gives 1760°K as the rocket chamber temperature, in good agreement with the 1770°K calculated from the composition of the powder.

R. C. MURRAY

536.48

8233. On the Bose–Einstein liquid model for liquid helium. I. He^3–He^4 mixtures. Z. MIKURA. *Progr. theor. Phys.*, **11**, 25–52 (*Jan.*, 1954).

A theory of He^3–He^4 mixtures is developed, in which He^3 is represented by a non-degenerate Fermi gas in a potential well, and He^4 by an assembly of Bose-particles in another potential well, each Bose-particle being considered to have a much larger mass than a He^4 atom and to have an energy gap between the ground state and the lowest excited state. Agreement between theory and experiment concerning the transition temperature and the vapour pressure in solution is satisfactory, if the energy of excitation is assumed to be proportional to the number density of He^4 "particles" in solution. The increase of the velocity of second sound in solution can be accounted for based on this theory under the condition that He^3 particles partake in the motion of the normal part particles, in contrast to Koide and Usui's conclusion. The osmotic pressure, the thermomechanical effect, and the specific heat in solution are also discussed. It is also remarked that the analogue, in solution, of Mendelssohn and Chandrasekhar's experiment would offer the most definite answer to the question which of the two theories is more tenable, de Boer and Gorter's or the present author's. Second sound for dilute solutions near the absolute zero of temperature is also discussed, and it is concluded that the square of the velocity should be there proportional to T and the proportionality coefficient is roughly equal to $R/3$. Theory and experiment are in general agreement also in this case.

A.

536.48

8234. Contribution from phonon-phonon interaction to the T^3 term of the specific heat of helium II. J. E. Lokken. Letter in *Canad. J. Phys.*, **32**, 359–60 (*May*, 1954).

There is a marked discrepancy between the experimental specific heat of liquid helium and the expression obtained for a quantum liquid by Kronig and Thellung [Abstr. 3255 (1953)]. Author derives a ("4th order") correction leaving a parameter which can be adjusted. This quantity can be determined independently, from the dispersion of sound; its significance is discussed. R. EISENSCHITZ

536.48 : 536.222

8235. Thermal conductivity of liquid helium below 1·0°K. H. A. Fairbank and J. Wilks. Letter in *Phys. Rev.*, **95**, 277–8 (*July* 1, 1954).

Measurements were made on a column of helium in a thin-walled metal tube of 0·29 mm diameter. Heat was supplied at one end and the temperature observed at two points of the tube. At temperatures below 0·6° the heat flow proved to be proportional to the temperature gradient even if it was varied by 10 to 1. Expressing the observed thermal conductivities in terms of the mean free path of phonons it is found that this path is at all temperatures comparable with the diameter of the tube. At temperatures between 0·6 and 0·9° the observed conductivity increases at a markedly higher rate with the temperature and may possibly depend on the gradient.

R. EISENSCHITZ

536.48

8236. Film flow in liquid helium II at low level differences. G. S. Picus. *Phys. Rev.*, **94**, 1459–67 (*June* 15, 1954).

Observations of the flow of the liquid helium II film have been made at very low level differences. To produce the flow a plunger is displaced vertically at an accurately controlled rate inside of a beaker of internal diameter of about one centimetre. By this means the initial behaviour when flow is started, the eventual steady-state behaviour, and the oscillations around the final equilibrium position after the plunger is stopped, are observed. The results obtained fit the form of equations derived by Atkins if, in addition, the existence of an upper limit to the velocity of flow is postulated. However, the period of the final oscillations is always found to be shorter than that deduced from the initial effects. The final periods also vary more slowly with temperature and more rapidly with the total length of the helium film than do the initial periods. Assuming the film thickness d varies with height h according to a relation $d = D/h^n$, it is found from the initial periods that $n \simeq \frac{1}{2}$ and from the final oscillations $n \simeq 1$. D, the thickness at a height of one centimetre, is approximately $2{\cdot}5 \times 10^{-6}$ cm, somewhat smaller values being obtained from the initial periods than from the final periods. These results are taken as evidence for the existence of a difference between the moving and the stationary film. Various mechanisms for producing the necessary redistribution of the material of the film, if this difference is simply a change in shape, are discussed. A.

536.48

8237. Experimental evidence for structure in the helium II film. W. C. Knudsen and J. R. Dillinger. Letter in *Phys. Rev.*, **95**, 279–80 (*July* 1, 1954).

A helium film is formed on copper wire and gradually made thinner by allowing part of it to creep away; alternatively its thickness is varied by varying the height of the wire above the level of liquid helium from where the film is supplied. The wire is brought into contact with liquid helium at one point so that the film tends to increase in thickness. Measurements are made of the time required for allowing the unsaturated film to become saturated. This time, it is found, changes abruptly between certain stationary values which are, within limits, independent of the preceding history of the film. The authors conclude that the film has a markedly high stability at certain degrees of thickness. R. EISENSCHITZ

536.52 : 536.46 : 535.33.03

8238. Measuring the temperature of a flame by the spectral line inversion method. A. G. Sviridov and N. N. Sobolev. *Zh. éksper. teor. Fiz.*, **24**, *No.* 1, 93–106 (1953) *In Russian.*

The method of the spectral line inversion is analysed, allowance being made for the finite width of the spectral lines and for the relationships between the continuous and line spectra. The feasibility is shown of measuring the temperature of a flame by using an optical set-up without any need for observing the actual inversion of spectral lines. The set-up includes a standard source which is projected by a lens into the flame containing, e.g. atomized Na salt. The images of both the flame and source are projected by a second lens on to the spectroscopic slit. The light-transmitting power of the latter lens ought not to exceed that of the former. A variant of the set-up enables photographic recording to be carried out instead of visual observation. F. LACHMAN

536.521

8239. Some consideration of the errors of brightness and two-colour types of spectral radiation pyrometer. E. C. Pyatt. *Brit. J. appl. Phys.*, **5**, 264–8 (*July*, 1954).

Expressions are derived for the errors of the two types and from them a chart, from which these errors can be calculated for any pyrometer for all possible values of emissivity. The limitations of both types for direct measurement of true temperature are discussed and the errors likely to result when true temperatures are calculated from apparent temperature from previous knowledge of emissivities. An expression is derived for the relation between the emissivities (ε_1 and ε_2) at the two-colour pyrometer wavelengths (λ_1 and λ_2) corresponding to a given ratio Z between the error of the two-colour pyrometer and the error of a brightness pyrometer working at one of the wavelengths (λ_2). This information is plotted as a chart of ε_1 against ε_2, the application of which to a practical problem is demonstrated. A more complex type of ratio pyrometer is put forward, enabling broader assumptions to be made regarding the emissivity/wavelength relation. A.

536.631 : 536.48

8240. The specific heat of lithium fluoride at low temperatures. G. O. Jones and D. L. Martin. Letter in *Phil. Mag.*, **45**, 649–50 (*June*, 1954).

Measurements show that Θ_D, after rising from

610°K at 80°K to 740K° at 20°K, remains constant at 736 ± 8°K between 2°K and 20°K. This agrees with the value calculated from (rather uncertain) elastic data. R. O. DAVIES

536.652

8241. Results of investigation at low temperature. XII. The heat of fusion of caesium. K. CLUSIUS AND H. STERN. *Z. angew. Phys.*, **6**, *No.* 5, 194–6 (1954) *In German.*

For Pt XI, see Abstr. 2371 (1954). Using a vacuum calorimeter the normal melting point of Cs is found to be 28·64 ± 0·17°C and the heat of fusion 520·1 ± 1·0 cal/g. atom. These values are compared with earlier measurements. R. O. DAVIES

THERMODYNAMICS 536.7/.8

536.7

8242. The thermodynamics of irreversible processes and its application to transport phenomena. I. H. G. REIK. *Z. Phys.*, **137**, *No.* 3, 333–61 (1954) *In German.*

The general transport equation is deduced from the author's general theory of irreversible processes based on the "time axiom" and the "integrability theorem" [Abstr. 5149–51 (1953), 3400 (1954)]. A close correspondence is found and discussed between the laws governing systems in which there is a discontinuous change of the state variables ("Überführungsphänomene") and systems in which the state variables are continuous functions of position (transport phenomena). The Onsager coefficients are obtained as the second partial derivatives of a single function; their dependence on the state variables (pressure, temperature) is discussed. In a final section the theory is freed from a special mean-free-path assumption made earlier. E. H. SONDHEIMER

536.7

8243. The thermodynamics of irreversible processes and its application to transport phenomena. II. H. G. REIK. *Z. Phys.*, **137**, *No.* 4, 463–93 (1954) *In German.*

A number of familiar relations concerning diffusion and ionic and electronic conduction are claimed by the author as being consequences of a general theory which, in spite of author's nomenclature, is not identical with the thermodynamics of irreversible processes as commonly understood. R. EISENSCHITZ

536.7

8244. The thermal force. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belgique Cl. Sci.*, **40**, *No.* 2, 98–102 (1954) *In French.*

The thermal field in a body with a temperature gradient is considered as an external field of force, comparable to the electrical or gravity field. Thermodynamic equations are given for this field.

C. TURNER

536.7

8245. Thermodynamic functions of hydrogen isocyanate. N. W. LUFT AND O. P. KHARBANDA. Letter in *J. chem. Phys.*, **22**, 956–7 (*May*, 1954).

These are calculated for an ideal gas at a total pressure of 1 atm for temperatures up to 1500°K.

C. TURNER

536.71 : 519.2 : 533.7

Further results on Monte Carlo equation of state. *See Abstr.* 8103

536.71 : 536.42

8246. Helium and the range of stability of the solid state. F. E. SIMON. *Proc. Amer. Acad. Arts Sci.*, **82**, *No.* 7, 319–30 (1953).

Melting pressures of helium are measured up to 9×10^3 atm (at 60°K). Entropy of the solid phase and entropy of fusion are found to increase with increasing temperatures. Helium has a transition point at 15°K. It is reported that L. S. Salter obtained the author's equation of the melting curve by combining the Lindemann formula with Grüneisen's equation of state. R. EISENSCHITZ

536.79 : 530.12

8247. Le Chatelier–Braun principle and relativity theory. M. v. LAUE. *Z. Phys.*, **137**, *No.* 1, 113–16 (1954) *In German.*

Let x_p, x_s be primary and secondary quantity-magnitudes and X_p, X_s the corresponding intensities, then the principle is stated as $(\partial x_p/\partial X_p)_{Xs} > (\partial x_p/\partial X_p)_{xs}$ and is illustrated by applications in relativistic thermodynamics, momentum being taken as an x_p, entropy and volume as x_s's, the corresponding intensities being velocity, temperature and negative pressure. R. A. NEWING

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.2

537.212

8248. Experimental determinations of the electric field and equipotential surfaces using the heat conduction analogy. M. K. GOHAR. Letter in *J. appl. Phys.*, **25**, 805–7 (*June*, 1954).

The temperature distribution in the thermal experiment provides the potential distribution in the electrical problem. The method is convenient for studying the electrical state of an insulator having a heterogeneous structure. If necessary 3-dimensional plots can be obtained. The considerable time involved in making the measurements is the chief disadvantage.

A. E. KAY

537.221

8249. Contact charging between nonconductors and metal. J. W. PETERSON. *J. appl. Phys.*, **25**, 907–15 (*July*, 1954).

An investigation has been made of the charging of fused quartz and borosilicate glass spheres rolling on a clean nickel surface. The results indicate that the process of acquiring charge depends only upon the nature and surface condition of the materials in contact and is independent of the pressure of an atmosphere of dry N_2. The total charge, however, is limited by gaseous discharge to the metal and therefore does depend upon the pressure. Such gaseous discharge has been verified by the observation of

individual discharge pulses. The rate of acquiring charge and maximum charge in vacuum has been found to depend upon rolling speed, both reaching a maximum at an intermediate speed, and to decrease with increasing surface conductivity. Since both fused quartz and borosilicate glass charge negatively in contact with clean nickel, it is inferred that both have higher effective work functions than nickel. The surface conductivity of borosilicate glass has been found to be three or four orders of magnitude higher than that of quartz. Therefore, since the charging of the two materials is of the same order of magnitude, the effective work function of the glass appears to be considerably higher than that of fused quartz. A.

537.226.1

8250. Orientation polarization from solution data. B. R. Y. Iyengar. Letter in *Curr. Sci.*, **22**, 370 (*Dec.*, 1953).

An expression derived by Palit (1952) differs from one derived by the author from the Clausius–Mosotti expression for dielectric polarization only because Palit assumes linear dependence of density of solution upon concentration, whereas the author assumes linear dependence of specific volume. For dilute solutions the expressions become identical. Even the observed linear dependence of dielectric constant upon concentration can be deduced from the Clausius–Mosotti expression. A. J. TAYLOR

537.226.2 : 538.565

8251. Some measurements on refractive indices of gases in the microwave region. F. W. Heineken and F. Bruin. *Physica*, **20**, 350–60 (*June*, 1954).

A method is described for measuring refractive indices of gases at atmospheric pressure and at a frequency of 25 000 Mc/s. The method is based on the change in resonance frequency of a cavity, first filled with a reference gas (nitrogen) and after that with the gas of which the refractive index is to be determined. However, instead of measuring the frequency change of a fixed cavity, the change is measured in length of the cavity, necessary to keep it tuned in both cases to the frequency of the (6,6) inversion line of ammonia. Subsequently the reading with a nitrogen filling is compared to the one of the evacuated cavity, so that all refractive indices are obtained with respect to vacuum. Results of these measurements for ten gases are given. As the absorption is extremely small and the inaccuracy of the measurements of refractive indices amounts to one or two parts in 10^6 for these gases, the introduction of a complex refractive index is found to be unnecessary. A.

537.226.2 : 548.7

8252. Dielectric properties of colored KCl crystals. T. Suita. *Phys. Rev.*, **94**, 1497 (*June* 15, 1954).

The dielectric properties of coloured KCl crystals were measured from 20° to 600°c by the resonance method at 3 Mc/s, and the number of colour centres by the conduction method. The dissociation energy of the colour centres in KCl was roughly calculated to be 0·36 eV from the data thus obtained. A.

537.226.2 : 536.7

8253. Thermodynamical theory of Seignette-electric substances with perovskite-type structure. G. A. Smolenskiĭ and R. E. Pasynkov. *Zh. éksper. teor. Fiz.*, **24**, *No.* 1, 69–77 (1953) *In Russian.*

Discusses the ferro-electric phase transition of the second kind from the cubic into tetragonal form for perovskite-type crystals, piezo-effect and electrostriction being allowed for. It is shown that the increase of spontaneous deformations below the Curie point causes an increase in the discontinuous change of specific heat and in the rate of increase of polarization with falling temperature. The tensor components for the dielectric permittivity are calculated for the cases both with and without elastic stresses in weak fields; coefficients of electrostriction and tensor components of the piezoelectric moduli are determined. It is shown that the permittivity of a constrained crystal is smaller than that of a free one.

F. LACHMAN

537.226.2 : 621.315.612.4 : 621.319.4

8254. On the unbalanced capacitance of a ferro-electric capacitor during charge. D. M. Kazarnovskiĭ. *Zh. tekh. Fiz.* **23**, *No.* 10, 1712–15 (1953) *In Russian.*

A comparison is drawn between the dielectric hysteresis curve and the graph of charge v. charging potential. An expression for the dynamic capacitance given by Yanus [Abstr. 6029 (1953)] is criticized on the basis of this comparison. It is concluded that the mean capacitance of such a capacitor under conditions of small leakage and d.c. charge can be obtained by conventional (ballistic) methods. [A comment on the above paper is made by N. P. Bogoroditskiĭ in *Zh. tekh. Fiz.*, **24**, *No.* 1, 149 (1954).] V. V. ZAKHAROV

537.226.3.08 : 621.317.335.3

8255. Measurement of ϵ' and ϵ'' of various solutions [liquids] at s.h.f. region by the 4-branched coaxial cable method (method 1). H. Yamamura. *J. Sci. Hiroshima Univ. A*, **16**, 353–65 (*Nov.*, 1952).

Four coaxial lines joining at a common point include the r.f. input, a crystal detector, and two lines with micrometer-adjusted shorting plungers. One of these is air-spaced and is used to determine the test wavelength, the other is filled with the liquid under test. The second plunger is moved through the liquid to determine $\lambda/2$ in the liquid and so ε'. A comparison of the detector outputs at the maximum positions as this plunger is moved, with those for displacements of the plunger $\lambda/8$ from the maximum positions determines ε''. Measured values for distilled water and for methyl, ethyl, ter-butyl and iso-amyl alcohols are tabulated for various temperatures at a wavelength of 7·4 cm. W. T. BLACKBAND

537.226.3.08 : 621.317.335.3

8256. Possibility of the concise treatment for the measurement of dielectric loss in u.h.f. region by the 4-branched coaxial cable. Y. Fujisaki and H. Yamamura. *J. Sci. Hiroshima Univ. A*, **16**, 547–50 (*May*, 1953).

An attempt is made to simplify the analysis developed in the preceding abstract. A comparison of successive maximum outputs as the plunger moves through the liquid-filled coaxial line determines the loss in the liquid. This is only accurate for liquids having relatively low loss. W. T. BLACKBAND

537.226.31

8257. The dielectric relaxation of glass and the pseudo-capacity of metal-to-glass interfaces, measured at extremely low frequencies. J. VOLGER, J. M. STEVELS AND C. VAN AMERONGEN. *Philips Res. Rep.*, **8**, 452–70 (*Dec.*, 1953).

The dispersion of the dielectric constant of a glass in the l.f. region has been investigated. The main relaxation time may be explained as the reciprocal transition probability of Na^+ ions jumping between adjacent interstices. Extremely high electrode capacities have been detected, which are frequency and temperature dependent. These are in qualitative agreement with a simple formula derived for the dynamic values of double-layer capacities. A.

537.226.33

8258. On the relaxation of dielectric losses in crystals with polar molecules at high frequencies. K. A. VODOP'YANOV. *Zh. tekh. Fiz.*, **24**, *No.* 1, 25–33 (1954) *In Russian.*

Loss curves up to 100 Mc/s are given for gypsum, talc and mica. Gypsum has two loss peaks at 20 and 3 Mc/s with tan δ 32×10^{-4} and 4×10^{-4} and activation energies $0{\cdot}61\times10^{-13}$ and $1{\cdot}41\times10^{-13}$ ergs respectively. D. H. WHIFFEN

537.226.33

8259. Dielectric absorption of amines in solution between 10^4 and 10^8 c/s. M. DAVIES AND A. H. PRICE. *J. Phys. Radium*, **15**, 307–9 (*April*, 1954) *In French.*

Tribenzylamine shows a Debye type absorption characterized by a single relaxation time, $5{\cdot}2\times10^{-9}$ sec in Nujol. In contrast triethylamine shows a narrower resonance type peak with ω_0 $4{\cdot}8\times10^8$ c/s and a concentration dependent relaxation time. It is suggested that the resonance is of the inversion frequency. D. H. WHIFFEN

537.226.33 : 539.132

8260. Dielectric relaxation time and association. III. E. FISCHER. *Z. Naturforsch.*, **9a**, 362–7 (*April*, 1954) *In German.*

For Pt II, see Abstr. 4787 (1953). Spectroscopic data show that the OH group of ortho-substituted phenol forms a hydrogen bridge with the other substituent. As the dipole moments of such compounds are sometimes independent of the concentration, it has been concluded that these molecules do not associate. This, however, is not conclusive, so measurements of the relaxation time (τ), which is proportional to the average volume of the particles, were carried out. *O*-cresol shows a strong increase of τ/η (η is the viscosity) with concentration, whilst *o*-chlorophenol only shows a slight increase, so the intramolecular H bond is much more prevalent in the latter compound. Guajacol and eugenol show a behaviour intermediate between the first two compounds but salicylaldehyde, *o*-oxyacetophenone and *o*-nitrophenol, for which a strong intramolecular H bridge was to be expected, show a definite association. A. J. TAYLOR

537.226.8

8261. Domain clamping effect in barium titanate single crystals. M. E. DROUGARD AND D. R. YOUNG. *Phys. Rev.*, **94**, 1561–4 (*June* 15, 1954).

The dielectric constant of good single crystals of barium titanate is found to decrease as the average polarization is decreased by means of an electric field. This has been interpreted as being due to a domain clamping effect arising from the multidomain situation in the crystal that accompanies the reduction in polarization. These measurements give a value for the coefficient of coupling of 0·50 which is in agreement with Caspari and Merz's value of d_{33} and the authors' measurement of S_{33}. The coupling coefficient has been studied as a function of temperature using this clamping effect. A.

537.226.8 : 536.424

8262. Theory of thermodielectric effect. B. GROSS. *Phys. Rev.*, **94**, 1545–51 (*June* 15, 1954).

A theory is put forth to explain the electrical effects which accompany phase changes occurring in dielectrics and aqueous solutions. Ionic movement in the interface is treated as a transition between energy levels separated by potential barriers. The height of the barriers and the value of the energy levels are supposed to be different for positive and negative ions. Such a model results in a net current flow across the solid–liquid interface. When the interface moves during a phase change of the system, the excess electric charges thus produced constitute space charges in the solid and surface charges in the liquid. The field of the global charge distribution causes the appearance of the currents and potential differences which have been observed between the plates of a condenser containing the dielectric. A.

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311 : 536.413.2 : 548.736.1

8263. Properties of plutonium metal. C. S. SMITH. Letter in *Phys. Rev.*, **94**, 1068–9 (*May* 15, 1954).

A brief statement of the early work on Pu which has now been declassified. There are five distinct phases below the melting-point (~ 637°C). Only the upper two have known structures, δ is b.c.c. and ε is f.c.c. Values of density, linear expansion coefficient, resistivity, and temp. coefficient of resistivity, are given for all phases. δ shows a negative coeff. of expansion, α a negative coeff. of resistivity. [See also Abstr. 6594 (1954)]. W. M. LOMER

537.311.31

8264. The electroconductivity of copper, nickel, cobalt, iron, and manganese in the solid and liquid states. N. P. MOKROVSKIĬ AND A. R. REGEL'. *Zh. tekh. Fiz.*, **23**, *No.* 12, 2121–5 (1953) *In Russian.*

This is measured experimentally by a magnetic method, described previously [Abstr. 4793 (1949)], the results showing deviations from the Perlitz law for a certain group of elements. The conductivities for melting Fe, Co and Mn are found to disagree with the Mott formula. A relationship is demonstrated between the electric conductivity and the position in the periodic table, for the metals investigated. V. V. ZAKHAROV

537.311.31 : 539.23

8265. Tentative explanation of the mechanism of conductivity of thin granular metallic films. N. NIFONTOFF. *C.R. Acad. Sci.* [*Paris*] **238,** 1870–2 (*May* 10, 1954) *In French.*

An interpretation of the conducting properties of thin metal films on the basis of a model in which grains of the metal are considered to be embedded in a semiconducting medium (formed of oxide, etc.) which occupies the space between them.

M. R. HOPKINS

537.311.32

8266. Electrical conductivities of natural graphite crystals. W. PRIMAK AND L. H. FUCHS. *Phys. Rev.*, **95,** 22–30 (*July* 1, 1954).

The principal electrical conductivities (σ_a in the basal plane and σ_c perpendicular to the basal plane) of graphite crystals isolated from several North American marbles were studied. By means of measurements of potential distributions on the surfaces of crystals carrying electric current, it was conclusively shown that σ_a/σ_c for these crystals is about several hundred at room temperature. By direct measurement σ_a was found to be $(2{\cdot}6 \pm 0{\cdot}2)\times10^4$ (ohm cm)$^{-1}$ and σ_c to vary from 150 to 230 (ohm cm)$^{-1}$ ($\pm$ 20%) at room temperature. Below room temperature it was found for two crystals that σ_a increased slowly to liquid nitrogen temperatures, then followed a T^{-1} law to about 15°K, and again slowly increased in the region 15°K to 4·2°K. Two other crystals for which σ_c was measured at low temperatures did not behave alike. For both, σ_c decreased as the temperature was lowered, reached a minimum above liquid nitrogen temperatures, and then started increasing, the one showing a T^{-1} behaviour, the other increasing more slowly. For both, the rate of increase declined markedly in the region 15°K to 4·2°K. A.

537.311.32 : 538.24 : 536.424

8267. Magnetic and electric properties of magnetite at low temperatures. B. A. CALHOUN. *Phys. Rev.*, **94,** 1577–85 (*June* 15, 1954).

The low-temperature transition in magnetite, according to Verwey, is due to the ordering of the ferrous and ferric ions in the octahedral interstices of the spinel lattice. This arrangement would require a symmetry change from cubic to orthorhombic. X-ray diffraction indicates and electric conductivity and magnetization measurements confirm that the transition leads to an orthorhombic structure. An external magnetic field applied while cooling through the transition establishes a preferred orientation for the *c* axis throughout the whole crystal. Below the transition this *c* axis can be switched to a new direction by a strong magnetic field, a process involving a co-operative rearrangement of the ferrous ions in new sites and relatively large changes in dimensions. In stoichiometric, synthetic, single crystals the transition occurs at 119·4°K and is marked by an abrupt decrease in the conductivity by a factor of 90 in a temperature interval of 1°. No thermal hysteresis is observed. The conductivity of a crystal cooled in a strong magnetic field is anisotropic below the transition as given by the relation $\sigma = A + B(1 + \cos^2\theta)$, where θ is the angle between the *c* axis and the direction of measurement. The ratio $B/(A + B)$ increases rapidly as the crystal is cooled to 90°K, indicating a progressive increase in the long-range order. The *c* axis is the direction of easy magnetization below the transition, and the anisotropy energy is very much larger below than above; the anisotropy constants have been determined at 85°K. A.

537.311.33

8268. Effect of the resonance scattering of current carriers in the impurity centres on electrical properties of atomic semiconductors. A. I. ANSEL'M. *Zh. éksper. teor. Fiz.*, **24,** *No.* 1, 83–9 (1953) *In Russian.*

The assumption is made that the presence of a discrete (or virtual) level of bonding energy of an electron brings about a resonance scattering of current carriers if the level considered is situated in the proximity of the lower boundary of the conductivity zone. It is shown that this scattering has a pronounced effect on the electrical properties of the semiconductor at low temperatures. The mobility of the current carriers at low temperatures varies as $T^{-\frac{1}{2}}$.

F. LACHMAN

537.311.33

8269. A device for the graphical determination of the Fermi-energy in semiconductors. E. MOOSER. *Z. angew. Math. Phys.*, **4,** 433–49 (*June*, 1953) *In German.*

Beside the Fermi-energy the temperature dependence of the carrier concentrations can be calculated for arbitrary degeneracy of the carriers in the conduction band and in the impurity levels.

F. ANSBACHER

537.311.33

8270. Towards the theory of the effect of strong fields in semiconductors. A. I. GUBANOV. *Zh. tekh. Fiz.*, **24,** *No.* 2, 308–19 (1954) *In Russian.*

Begins with a short survey of experimental and theoretical work on the subject. Two particular mechanisms, thermoelectronic ionization and shock ionization are chosen for discussion in the light of theory due to Frenkel [*Zh. éksper. teor. Fiz.*, **8,** 1893 (1938)], and related to the behaviour of solid rectifiers.

W. BARDSLEY

537.311.33

8271. A model for optical transitions in impurity semiconductors. I. W. REICHARDT. *Z. Phys.*, **137,** *No.* 4, 503–15 (1954) *In German.*

The one-electron problem for a perturbed Kronig–Penney potential is solved. The perturbation potential is constant in one cell, giving rise to levels in the forbidden band and selection rules for optical transitions from the bands to these levels. The transition probability increases with increasing energy difference between edge of band and impurity level.

F. ANSBACHER

537.311.33

8272. On the theory of radiationless recombination in nonpolar semiconductors. L. TEWORDT. *Z. Phys.*, **137,** *No.* 5, 604–16 (1954) *In German.*

The theory of Huang and Rhys [Abstr. 3196 (1951)] for the corresponding processes with *F*-centres is modified and extended to the case of non-polar lattices. The energy is released via the acoustic modes of the lattice which is considered as discontinuous. C. A. HOGARTH

537.311.33

8273. Photovoltaic effect in *p-n* junctions. R. L. CUMMEROW. *Phys. Rev.*, **95**, 16–21 (*July* 1, 1954).

The relations between the incoming radiant energy and the outgoing electrical energy are developed in terms of the experimentally measurable constants of the semiconducting material. These results are applied to germanium by making use of constants found in the literature. The high efficiencies calculated for power conversion are strong indication that the *p-n* junction may be a practical device for the direct utilization of solar energy. A.

537.311.33 : 537.32 : 621.314.7

8274. An explanation of some anomalous thermoelectric phenomena on the surface of transistor materials. J. TAUC. Letter in *Czech. J. Phys.*, **3**, 259 (*Sept.*, 1953).

The anomalous surface layer reported by Granville and Hogarth [Abstr. 6968 (1951)] is considered to arise through deformation of the crystal lattice near the surface, caused by stresses during polishing. By considering an assembly of semiconductor with a surface layer of opposite conductivity type, the reversal of thermo-e.m.f. of a point contact on warming up the crystal may be explained on the basis of a theory due to Tauc and Trousil [Abstr. 6635 (1954)]. C. A. HOGARTH

537.311.33 : 538.632

8275. A method of measuring the Hall effect in semiconductors. V. P. ZHUZE AND S. N. NIKOLAEV. *Zh. tekh. Fiz.*, **23**, *No.* 5, 913–23 (1953) *In Russian.*

The shortcomings of d.c. measurements of the Hall e.m.f. are reviewed and an a.c. method is suggested for overcoming these. The magnetic field and the current through the specimen were both alternating and of differing frequencies, the Hall e.m.f. being measured at 20 c/s through a narrow-band (0·2 c/s) amplifier with an electrometer input. A detailed description and circuitry of this amplifier and associated apparatus is given. The sign of the Hall effect is determined from oscilloscopically displayed Lissajou's figures, this being used to demonstrate the sign reversal of the Hall effect in Cu_2O in the region 550–650°C. V. V. ZAKHAROV

537.311.33 : 537.312

8276. The dependence of the electrical conductivity of cadmium sulphide single crystals on wavelength under X-radiation and γ-radiation. G. FROHNMEYER, E. R. GLOCKER AND D. MESSNER. *Z. Phys.*, **137**, *No.* 1, 117–25 (1954) *In German.*

The variation of the conductivity of CdS crystals with wavelength over the range 2000 to 10XU was determined by measurement of the crystal current and the ionization current of the X-rays in air. The results confirmed the assumption that the effect is due only to the fraction of X-ray energy which is converted to energy of the photoelectrons and Compton electrons. J. FRANKS

537.311.33

8277. Some properties of *p*-type gallium antimonide between 15°K and 925°K. H. N. LEIFER AND W. C. DUNLAP, JR. *Phys. Rev.*, **95**, 51–6 (*June* 1, 1954).

Gallium antimonide has been produced by direct combination of gallium and antimony under hydrogen. The product was zone refined and pulled in single crystal form using the Czochralski technique. The product was *p*-type, with resistivities in the range 0·08–0·1 ohm cm. Hall coefficient and resistivity were measured in the temperature range 15–925°K. The slope of the Hall curve at low temperatures yielded the value 0·024 eV for the ionization energy of the carriers. It has been shown necessary to assume an additional acceptor level at 0·037 eV. The room temperature mobility of several samples was about 800 cm²/volt sec. The Hall mobility varied as $T^{-0.87}$ in the temperature range below room temperature, but the slope changed at about room temperature, and shifted nearly to a $T^{-\frac{3}{2}}$ law in the higher temperature range. The Hall coefficient changed sign at 357°C, as the sample became intrinsic. The mobility ratio was determined from the ratio of the extrapolated extrinsic resistivity and the actual resistivity at the Hall inversion temperature. The value was about 5. The effective mass and intrinsic band gap were estimated from the resistivity data and infrared measurements. The best values were estimated to be $0{\cdot}20m$ for the effective mass of electrons, $0{\cdot}39m$ for holes and 0·80 eV for the intrinsic band gap at 0°K. The best value for room-temperature band gap was taken to be 0·71 eV; the coefficient of band gap with temperature 3×10^{-4}/deg C. A.

537.311.33

8278. High field effects in germanium. E. M. CONWELL. Letter in *Phys. Rev.*, **94**, 1068 (*May* 15, 1954).

Possible mechanisms are discussed for the origin of the high current density with electric field which occurs for fields of about 10 V/cm at 20°K. C. A. HOGARTH

537.311.33

8279. Energy of the high-lying acceptor level in copper-doped germanium. J. F. BATTEY AND R. M. BAUM. Letter in *Phys. Rev.*, **94**, 1393 (*June* 1, 1954).

Hall coefficient and resistivity measurements on copper-doped germanium so treated as to fill partially the upper copper level, are reported and yield evidence for an activation energy of about 0·3 eV (above the filled band). C. A. HOGARTH

537.311.33

8280. Conductivity and Hall effect in the intrinsic range of germanium. F. J. MORIN AND J. P. MAITA. *Phys. Rev.*, **94**, 1525–9 (*June* 15, 1954).

Conductivity and Hall effect have been measured in the intrinsic range of germanium from 250° to 1000°K. From lattice-scattering mobility and conductivity below 500°K, a new empirical expression for carrier concentration is determined: $np = 3\cdot10\times10^{32}T^3\exp(-0\cdot785/kT)$. An estimate is made of the contribution of optical modes to the lattice-scattering mobility. Conductivity from 500° to 1000° and Hall effect from 250° to 1000° are computed and compared with experiment. Included in the computation are: the empirical expression for carrier concentration modified by the change in intrinsic ionization energy produced by electrostatic interaction of charge carriers, extrapolated empirical lattice scattering mobility, scattering by electron-hole collisions, and

an extrapolation of the ratio Hall mobility/conductivity mobility. A.

537.311.33

8281. Photon-radiative recombination of electrons and holes in germanium. W. VAN ROOSBROECK AND W. SHOCKLEY. *Phys. Rev.*, **94**, 1558–60 (*June* 15, 1954).

The spectral distribution of the rate of photon generation for the photon-radiative recombination of electrons and holes in germanium is determined from known optical properties by application of the principle of detailed balance. Quantities characterizing the process are evaluated: The thermal equilibrium recombination rate at 300°K is $1{\cdot}57\times 10^{13}$ cm^{-3} sec^{-1}, which corresponds to a recombination cross-section of $2{\cdot}9\times 10^{-21}$ cm^2 and a decay time for a small disturbance in carrier concentration in intrinsic material of 0·75 sec. The extension to the steady-state case of added current carriers is given, and estimates are included of the dependence of the quantities on temperature. A.

537.311.33

8282. Recombination of holes and electrons at lineage boundaries in germanium. F. L. VOGEL, W. T. READ AND L. C. LOVELL. Letter in *Phys. Rev.*, **94**, 1791 (*June* 15, 1954).

Travelling-light-spot experiments are shown to reveal a "surface recombination velocity" for a lineage boundary consisting of an array of dislocations in germanium. C. A. HOGARTH

537.311.33

8283. Vacancies and interstitials in heat treated germanium. S. MAYBURG. *Phys. Rev.*, **95**, 38–43 (*July* 1, 1954).

Annealing experiments on the thermal acceptors quenched into germanium by rapid cooling from high temperatures are used to deduce information about vacancies and interstitials in germanium. Annealing is studied at a series of temperatures and a critical temperature is found at 516°C. Above 516°C, the annealing curves suggest a bimolecular recombination process implying that the heat treatment produces comparable numbers of vacancies and interstitials (Frenkel defects) which disappear by mutual annihilation. Below 516°C, the data can be explained by a model in which interstitials are trapped near dislocations before much recombination can occur with vacancies. As a result of these experiments and their interpretation, interstitials are believed to be more mobile than vacancies below, and possibly above, 516°C. A.

537.311.33 : 535.343–15

8284. The contribution of free charge carriers in germanium to absorption in the near infrared. J. JAUMANN AND R. KESSLER. Note in *Z. Naturforsch.*, **9a**, 476 (*May*, 1954) *In German.*

537.311.33 : 538.63

8285. Theory of the galvanomagnetic effects in germanium. B. ABELES AND S. MEIBOOM. *Phys. Rev.*, **95**, 31–7 (*July* 1, 1954).

A simple anisotropic theory of the galvanomagnetic effects in germanium is presented. It is assumed that the energy as a function of momentum has a number of extrema; near the extrema the energy is approximated by a quadratic function of momentum, and the relaxation time is assumed to be a function of energy only. Equations for the galvanomagnetic coefficients in any crystallographic direction are derived. The dependence of the coefficients on magnetic field strength is calculated and an expression for the ratio between Hall mobility and conduction mobility is obtained. The calculated values of the magnetoresistance are compared with measurements of Pearson and Suhl. The agreement between the calculated and the observed values is satisfactory in *n*-germanium, but not in *p*-germanium. A.

537.311.33 : 538.632

8286. Hall coefficient in germanium. T. C. HARMAN, R. K. WILLARDSON AND A. C. BEER. Letter in *Phys. Rev.*, **94**, 1065–7 (*May* 15, 1954).

Differences between mobility values as computed from Hall coefficient and conductivity, and those computed from drift experiments may result from the inadequacies of the weak-field Hall equations in giving the correct values for carrier concentrations in extrinsic *p*-type Ge. Hall coefficients determined from strong-field asymptotic behaviour are in good agreement with results of drift measurements and also remain relatively constant with decreasing temperature. A. E. DE BARR

537.311.33 : 539.217

8287. Diffusion of impurities in germanium. W. C. DUNLAP, JR. *Phys. Rev.*, **94**, 1531–40 (*June* 15, 1954).

A method is described for the study of diffusion of impurities in semiconductors; results are obtained by the observation of the *p-n* junction formed as the diffusing impurity penetrates the specimen. Studies have been made upon germanium using this technique, and comparisons with the radioactive tracer method have shown the *p-n* junction method to give valid results. Measurements on indium, gallium, aluminium, arsenic, boron, phosphorus, antimony, and zinc are described. The diffusion coefficients of these elements in germanium range, at 900°C, from 10^{-12} cm^2/sec to 10^{-9} cm^2/sec. The activation energy for bulk diffusion in germanium is about 2·5 eV, or 57 000 cal/mole. Applications are given for the study of the *p-n* junction method to the study of surface and grain-boundary diffusion. The method has also been applied to the study of new elements and their electrical activity in germanium. It is concluded that the rapidity with which results can be obtained by the junction method, and its applicability to elements not conveniently available in radioactive form make it a valuable adjunct to the radioactive tracer method for studying diffusion. A.

537.311.33 : 535.345 : 548.7

8288. Comparison of compounds of the MoS_2 family (structure and optical and electrical properties). J. LAGRENAUDIE. Letter in *J. Phys. Radium*, **15**, 299–300 (*April*, 1954) *In French.*

537.311.33 : 669.776 : 621.3.011.22

8289. Electrical properties of microcrystalline selenium. G. HALVERSON. *Commun. and Electronics*, *No.* 11, 38–45 (*March*, 1954).

The crystalline state of commercial-grade Se depends markedly upon the thermal treatment it receives and its impurity content. The effect of iodine content, temperature and time on crystal

structure and resistivity is illustrated in graphs and micrographs. W. BARDSLEY

537.311.33 : 548.5

Observations on CdS crystals by microscopic examination and conductivity measurements. *See Abstr.* 8758

537.311.33

8290. Experimental results in the selection of germanium rectifiers. P. GOUDAL. *Cahiers de Phys., No.* 49, 65–6 (1954) *In French.*

537.311.33

8291. The nature of the electrical contact by studies on single crystals of cadmium sulphide. I. W. M. BUTTLER AND W. MUSCHEID. *Ann. Phys.* [*Leipzig*] **14,** *No.* 3–5, 215–19 (1954) *In German.*

537.311.33 : 621.314.632

8292. The dependence of capacitance and rectification on frequency of a point contact metal–semiconductor (lead sulphide). D. N. MIRLIN AND I. L. SOKOL'SKAYA. *Zh. tekh. Fiz.*, **23,** *No.* 9, 1582–90 (1953) *In Russian.*

Inversion and non-inversion rectification properties are examined for varying frequencies especially for $f = 1 - 10$ Mc/s for both mono- and polycrystalline semiconducting specimens of PbS, Ge and others. The thickness of the barrier layer is estimated and the capacity measured. Results for PbS at 12 Mc/s are tabulated. Several processes are examined which may have an effect on rectification at high frequencies, and their relaxation times estimated. V. V. ZAKHAROV

537.311.37

8293. Measurement of the conductivity of a jet flame. F. P. ADLER. *J. appl. Phys.*, **25,** 903–6 (*July*, 1954).

A method for the measurement of the complex conductivity of a rocket exhaust flame is described. Typical results are shown for an acid-aniline rocket motor and a frequency of 200 Mc/s. The importance of sodium impurities is pointed out and illustrated experimentally. A.

537.311.62

8294. Theory of anomalous skin effect in a magnetic field. M. YA. AZBEL' AND M. I. KAGANOV. *Dokl. Akad. Nauk SSSR*, **95,** *No.* 1, 41–4 (1953) *In Russian.*

The surface impedance of a metal is calculated for plane electromagnetic waves of frequency ω incident normally on it when a magnetic field is applied also normal to the surface. The result is similar to that given by Reuter and Sondheimer in the absence of a magnetic field except that ω is replaced by $\omega \mp \Omega$, where Ω is the Larmor frequency (more precisely $\Omega = veH/pc$, if the momentum p is not related to the velocity by $p = mv$), the impedance being defined as

$$Z_{\pm} = \frac{4\pi}{c} \frac{E_x(0) \pm iE_y(0)}{H_y(0) + iH_x(0)}.$$

D. SHOENBERG

537.312.5

8295. The photoeffect in zinc. V. STŘELKA. Letter in *Czech. J. Phys.*, **3,** 168–9 (*June*, 1953) *In Russian.*

Bombardment of Zn by electrical discharge in O_2 causes a shift in the photoelectric threshold sensitivity to shorter wavelength. In H_2 and N_2 the shift is to longer wavelength. For H and O this is soluble in terms of a chemically adsorbed layer but another explanation is necessary for N, which may involve an azide or nitride lattice formed on the Zn. Further enquiry into this point will be published.

W. BARDSLEY

537.312.5

8296. On certain singularities of the photoelectric current in single crystals of cadmium sulphide. S. M. RŸVKIN AND L. G. PARITSKIĬ. *Zh. tekh. Fiz.*, **24,** *No.* 1, 3–17 (1954) *In Russian.*

An experimental investigation of the photoelectric current, photorectification, the current-voltage relations under illumination near the cathode, heterogeneous or non-uniformly illuminated specimens, the dependence of photocurrent under infrared illumination and the counting of α particles.

W. BARDSLEY

537.312.5

8297. Tentative electronic interpretation of the delay in response of photocells. G. BLET. *C.R. Acad. Sci.* [*Paris*] **238,** 1704–5 (*April* 26, 1954) *In French.*

The usual explanations of the action of barrier-layer cells involve the concepts of internal capacitance and resistance. The variation of these quantities with the intensity of incident radiation and with current through the cell is calculated assuming (*a*) the photoelectrons produced are governed by Lambert's law and by a law of scalar distribution of velocities, and (*b*) the conductivity of the blocking layer is proportional to the concentration of free charge carriers it contains. C. A. HOGARTH

537.312.5

8298. The photoconductivity of anthracene. I. A. G. CHYNOWETH AND W. G. SCHNEIDER. *J. chem. Phys.*, **22,** 1021–8 (*June*, 1954).

Pure crystals of anthracene became photoconducting when illuminated with wavelengths lying within their fundamental absorption band. The majority carriers were positive holes, which, as they drifted through the crystal, took part in trapping processes. From the variation of the photocurrent with temperature it was concluded that the number of positive hole traps fell off exponentially as their height above the valence band increased. From the behaviour of the photocurrent at various applied fields and light intensities, it was concluded that the conventional energy band diagram as used for inorganic substances could be applied to organic compounds also. Evidence was found, however, indicating that there were large potential irregularities in the energy levels throughout the crystal. A.

537.312.5

8299. The effect of oxygen on the photoconductivity of anthracene. II. A. G. CHYNOWETH. *J. chem. Phys.*, **22,** 1029–32 (*June*, 1954).

The photoconductivity in the surface layers of crystalline anthracene has been found to increase considerably over its vacuum level when it is measured in the presence of oxygen or air. Replacing the oxygen by nitrogen or argon causes no such increase. The increased photoconductivity is attributed to the photo-oxidation of the surface, both the light and the oxygen being necessary to produce the effect. No reaction takes place in the dark. The oxide formed is fairly unstable and dissociates in the dark. Its rate of dissociation is considerably increased when the

crystal is illuminated in the absence of oxygen. The experiments indicate that the peroxide is formed by a two-stage process, the highly unstable intermediate product being formed very rapidly while the final peroxide is formed much more slowly. The nature of the intermediate product is not known for certain. The end product is very likely the oxide formed by an oxygen bridge across the 9, 10 carbon atoms of the anthracene molecule. Apparently, both the oxidation products modulate the photocurrent solely by their effect on the mean free path of the carriers; the intermediate product producing a relatively large increase while the end product produces a smaller decrease in the mean free path. It is suggested that the technique of photoconductivity measurements might prove to be useful in the study of the kinetics of certain photochemical reactions. A.

537.312.5

8300. Photoconductivity in gold-doped silicon. R. NEWMAN. *Phys. Rev.*, **94**, 1530–1 (*June* 15, 1954).

Photoconductivity has been studied in *p*-type gold-doped silicon at 20°K, 77°K and 195°K. The impurity photoconduction shows a temperature dependence. At 20°K and 77°K, the data indicate a simple photoconductive process with a threshold at about 0·33 eV. At 195°K, the data indicate a complex photoconductive spectrum. A.

537.312.5 : 535.33.07 : 535.339–32 : 621.383

8301. Fabrication of photoemissive receivers for the far ultraviolet. Photoemissive cells and electron multipliers. V. SCHWETZOFF. *Rev. gén. Elect.*, **63**, 71–96 (*Feb.*, 1954) *In French.*

Deals with photocells for wavelengths below 2000 Å and with a vacuum monochromator. Pt I summarizes existing knowledge of photoelectric and secondary emission and considers the question of s./n. ratio in valve amplifiers, G.M. counters and multiplier photocells. Pt II contains an experimental study of the monochromator and cells. Improved methods of preparing the Cs on an oxidized Ag surface are described (resulting in less thermionic emission for the same photoelectric yield), as is work on the antimony alloys (Sb–Cs, Sb–K, Sb–Na and Sb–Li). Down to 1500 Å Sb–Cs and Sb–K are of practical importance, the latter giving especially small thermionic emission. Multipliers with Cu–Be plates were directly fitted on the vacuum monochromator and gave thermionic currents $>10^{-16}$ A/cm^2. It was not found possible to determine the absolute yield of the surfaces but it is hoped to do this subsequently. A bibliography of 199 items is included.

A. H. W. BECK

537.312.5 : 537.531

8302. Photo-voltaic effect caused by X-rays at *p-n* junctions in germanium. J. BAČKOVSKÝ, M. MALKOVSKÁ AND J. TAUC. Letter in *Czech. J. Phys.*, **4**, 98 (*Feb.*, 1954).

The voltage appeared immediately the irradiation began. With an inverse current through the junction the change of current was up to 10^3 times the standing current. This change was a slow one, so that secondary processes are probably involved, as well as the major one of X-ray quantum absorption followed by the production of about 10^4 hole-electron pairs. There is an application for X-ray dosimetry.

C. A. HOGARTH

537.312.5 : 538.63

8303. Photomagnetoelectric effect in germanium and silicon. H. BULLIARD. *Phys. Rev.*, **94**, 1564–6 (*June* 15, 1954).

The transient part of the photomagnetoelectric (p.m.e.) voltage in germanium has been studied. It has been observed that the p.m.e. voltage reached its steady-state value by passing through a maximum instead of reaching it by progressive increase. The p.m.e. effect in silicon has been observed and a few experimental results are given. A.

537.312.5 : 538.639

8304. Photoconductivity and photoelectromagnetic effects in InSb. S. W. KURNICK, A. J. STRAUSS AND R. N. ZITTER. Letter in *Phys. Rev.*, **94**, 1791 (*June* 15, 1954).

Measurements at 300°K and 77°K are reported for *p*-type InSb (intrinsic at room temperature) with 7×10^{15} acceptors/cm^3. The results agree well with previous theoretical and experimental results, but there are certain inconsistencies, as, for example, between the lifetimes deduced from photoconductive or photoelectromagnetic measurements.

C. A. HOGARTH

537.312.5 : 621.383.27

8305. On the origin of large-amplitude pulses in the noise from a photomultiplier. Y. KOECHLIN, I. PELCHOWITCH AND A. ROGOZINSKI. Letter in *C.R. Acad. Sci.* [*Paris*] **238**, 660–2 (*Feb.* 8, 1954) *In French.*

The glass of the EMI 6260 tube tested contains a certain amount of the K^{40} isotope. This isotope produces scintillations with an efficiency of about 1% that of anthracene. A. H. W. BECK

537.312.6

8306. Pauli principle scattering and the resistivity minimum. J. S. KOEHLER. Letter in *Phys. Rev.*, **94**, 1071–2 (*May* 15, 1954).

Suggested interpretation of the minimum in the electrical resistivity of metals at low temperatures, based on the idea that grain boundaries can give rise to electron scattering which becomes more effective as the temperature is lowered. E. H. SONDHEIMER

537.312.62

8307. Contribution to the theory of superconductivity. B. T. GEĬLIKMAN. *Dokl. Akad. Nauk SSSR*, **94**, 659–62 (1954) *In Russian.*

If electrons in a superconductor are regarded as a quantum liquid carrying a charge, the author's approach to quantum hydrodynamics [Abstr. 6572 (1954)] lends itself readily to a theory of superconductivity. It is only necessary to add the energy of the electromagnetic field and of field-matter interaction to the Hamiltonian of the liquid. In the course of the deductions the author introduces quantized wave-functions which are appropriate to bosons rather than to fermions; he gives reasons to justify this procedure. The zero and first approximations of author's theory yield the relation between electronic momentum and magnetic field strength as established by F. and H. London. R. EISENSCHITZ

537.312.62

8308. Boundary phenomena for current flow between a normal conductor and a superconductor. G. U. SCHUBERT AND K. H. SCHRAMM. *Z. angew. Phys.*, **6**, *No.* 5, 221–5 (1954) *In German.*

The problem of a boundary across an infinite plate is treated by assuming that Ohm's law applies in the normal conductor and the equations of F. and H. London in the superconductor. The mathematical analysis originally given by F. London involves approximations which break down in the immediate neighbourhood of the boundary and a more precise mathematical treatment is given here. D. SHOENBERG

537.312.62 : 535.345

The optical constants of tin below the superconducting transition temperature. *See Abstr.* 8179

ELECTRIC DISCHARGES 537.52

537.521

8309. Transition processes in a plane-bounded plasma. R. L. STRATONOVICH. *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 269–78 (1953) *In Russian.*

Boundary values are found for (1) the deviation from the equilibrium distribution function, (2) potential of the electric field and (3) gradient of charge density, in processes which take place in a semi-space when a given potential is applied to a plane reflecting electrode which acts as the plasma boundary. A method is described of determining transition processes in a semi-infinite plasma and in a layer between 2 electrodes maintained at a constant potential difference, using a special form of stationary function of distribution. Formulae are obtained which express the reaction of the plasma to different disturbances, in particular to the function with a rectangular well [$H(t) = 1$ at $t \geqslant 0$; $H(t) = 0$ at $t < 0$]. F. LACHMAN

537.523.3 : 533.6.013.22

On the use of corona discharges in the measurement of turbulence. *See Abstr.* 8100

537.523.3 : 621.3.014.31 : 621.3.015.532

8310. Pressure effects of ionic currents in atmospheric air with various discharge arrangements. E. LÖB. *Arch. elekt. Übertragung*, **8**, 85–90 (*Feb.*, 1954) *In German.*

The relations between the direct discharging current and the static pressure observed under certain conditions with corona discharges in air under atmospheric pressure at points or thin wires are derived analytically for different electrode configurations. The equations given hold within limits also for the alternating pressure resulting with a superimposition of a.c. on the discharge d.c. The range of validity of the theoretical results given is ascertained experimentally on a point discharge gap as an "ionic sound source." A.

537.523.4

8311. Photoelectric investigation of the spectrum of the channel of a spark discharge. L. A. VAĬNSHTEĬN, A. M. LEONTOVICH, L. P. MALYAVKIN AND S. L. MANDEL'SHTAM. *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 326–38 (1953) *In Russian.*

Describes the procedure and apparatus for photoelectric recording (with the use of an oscillograph) of the intensities of spectral lines in the unit impulse of the spark discharge. For the intensities of spectral lines of N at different degrees of ionization and of the H_α line, their variation is investigated during the process of generation of the spark discharge. Some regularities have been established for the spectrum excitation in the channel of the discharge. E.g. the relative intensity of 3 pairs of N II lines with different energies of excitation of upper levels varies the less during the discharge the smaller the difference between the energies of upper levels for the lines involved. This leads to the assumption $I = A \exp(-E/kt)$, i.e. that the distribution of atoms on the excitation levels is of the Boltzmann type. F. LACHMAN

537.525

8312. Concentration of metastable atoms in the positive column of a low-pressure discharge. YU. M. KAGAN AND V. I. PEREL'. *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 319–25 (1953) *In Russian.*

In an attempt at calculating the concentration of metastable atoms when the free path for collisions between metastable and normal atoms exceeds the radius of the tube, the author develops expressions for this concentration in the positive column of a low-pressure discharge, allowance being made for second-kind collisions with electrons. No secure data being available so far for the cross-sections of the processes of formation and decomposition of metastable atoms, the theory proposed is only compared qualitatively with experimental data obtained by Fabrikant, Butaeva and Cirg (1937, 1938); and Kagan and Penkin [Abstr. 6536 (1952)]. The results of comparison are satisfactory. F. LACHMAN

537.525

8313. The frequency of the irradiating light as a determinant of the Joshi effect in oxygen under silent electric discharge. S. R. MOHANTY. *J. chem. Phys.*, **22**, 1010–11 (*June*, 1954).

Ceteris paribus, the negative Joshi effect $-\Delta i$ in oxygen under electrical excitation increases linearly with the frequency ν of the irradiating light: $-\Delta i/i_D = A(\nu - \nu_m)$, where i_D is the r.m.s. current in dark, ν_m the minimum threshold frequency and A a constant dependent upon the nature of the electrode surface, gas pressure, applied potential V, etc., ν_m decreases with increase in V because of the occurrence of the photoelectric analogue of the Schottky effect. The increase in $-\Delta i$ with $\nu(>\nu_m)$ is the consequence of a similar variation in the photoelectric yield. Superimposed on this are factors which tend to reduce $-\Delta i$: (1) the increase in photoelectron energy with ν, which diminishes the probability of attachment, and (2) reduction in emission because of the negative space charge and the image force. A.

537.525

8314. Electron energy distributions in stationary discharges. I. B. BERNSTEIN AND T. HOLSTEIN. *Phys. Rev.*, **94**, 1475–82 (*June* 15, 1954).

Calculations of the electron distribution function are presented for some simple examples of a stationary discharge in a d.c. space charge field. The treatment is valid when the predominant mechanism of energy exchange arises from motion in the d.c. space charge field. The computations indicate that the effect of d.c.

space charge is, for a given external field strength, to increase the proportion of high-energy electrons over that computed neglecting space charge. This results in a larger specific ionization rate, but the effect is not so great as to account for the low maintenance potentials observed in positive columns and in microwave discharges in inert gases. A.

537.525 : 537.533.8

8315. A reversible fatigue phenomenon of secondary emission from glow cathodes with semiconducting component layers. W. KLUGE AND A. SCHULZ. *Z. Phys.*, **137**, *No.* 3, 392–400 (1954) *In German.*

Measurements of glow discharge current in a photocell filled with argon at 0·1 mm Hg shows that if the cathode has semiconducting layer a reduction of current with time is observed, similar in character to the fatigue phenomena in photoelectric emission and which can be reversed by infrared irradiation. The phenomena is discussed in terms of the action of the semiconducting layer in enabling electrons from the metal to reach emitting centres (in this case caesium ions) near the surface. C. G. MORGAN

537.525.5 : 537.525.8

8316. The current-voltage characteristic of a self-sustained gaseous discharge in a transverse magnetic field. R. HAEFER. *Acta phys. Austriaca*, **8**, *No.* 3, 213–24 (1954) *In German.*

The current-voltage relations, for pressures varying from about 0·1 mm Hg to about 10^{-7} mm Hg, are given for argon discharges in a 1500 gauss field. They are then discussed, in terms of the space-charge conditions, etc., in the discharge. J. D. CRAGGS

537.525.8 : 535.33.03 : 539.133

8317. On diacetylene glow discharges. H. SCHÜLER AND L. REINEBECK. *Z. Naturforsch.*, **9a**, 350–4 (*April*, 1954) *In German.*

A discussion of the emission spectra of diacetylene, with particular reference to the various bands that are excited in glow discharges. Finally, a short-discussion of the bearing of these results on molecular structure is given. J. D. CRAGGS

537.525.82

8318. The anode fall in a glow discharge. C. J. F. CHAUNDY. *Brit. J. appl. Phys.*, **5**, 255–6 (*July*, 1954).

Observations of the electric field in the anode fall region of a glow discharge in nitrogen are made here by measuring the deflection of an electron beam. The results with a plane anode show agreement with theory: the anode fall is approximately the same as the ionization potential of the gas, and the width of the anode dark space is of the size expected. A.

537.527.5

8319. On the composition of the continuous radiation from high-pressure mercury discharges. F. RÖSSLER. *Z. Phys.*, **137**, *No.* 5, 617–31 (1954) *In German.*

Discusses principally the continua which may be attributed to interatomic collision processes designated by $(6^1S_0 + 6^1P_1)$ and $(6^1S_0 + 7^1P_1)$. Critical potentials, intensity variations with pressure and other aspects of these reactions are studied, and compared with experimental data. Other processes which also may give detectable continua are more briefly discussed. J. D. CRAGGS

537.527.5 : 535.33.03–15

8320. The long-wavelength infrared emission from high-pressure plasmas considered as a bremsstrahlung spectrum. G. HETTNER. *Z. angew. Phys.*, **6**, *No.* 5, 209–12 (1954) *In German.*

The wavelength range considered is $\sim 0{\cdot}001$ to $0{\cdot}1$ cm. This theoretical paper gives derivations of intensity wavelength formulae and also gives some consideration of absorption of radiation in the outer layers of discharges. J. D. CRAGGS

537.529

8321. Theory of internal field emission in cubic crystals. J. HOMILIUS AND W. FRANZ. *Z. Naturforsch.*, **9a**, 205–10 (*March*, 1954) *In German.*

A continuation of earlier work [Abstr. 2634, 5636 (1954)]. The conditions for and the extent of the electrical breakdown due to interband transitions are derived for cubic crystals. A directional dependence of the breakdown field strength is obtained. The formulae are based on the nearly-free-electron approximation and include the magnitudes of the energy gaps in various directions. Application is made to PbS, PbTe, Si and Ge. E. P. WOHLFARTH

537.529

8322. A note on the nature of dielectric breakdown. K. W. BÖER AND U. KÜMMEL. Note in *Z. Naturforsch.*, **9a**, 267–8 (*March*, 1954) *In German.*

The effect of thermal conditioning on the voltage-current characteristics of CdS crystals has been investigated, in order to show that pre-breakdown currents are due to the excitation of trapped electrons. J. H. MASON

X-RAYS 537.531

537.531 : 535.32

8323. Anomalous dispersion and scattering of X-rays. L. G. PARRATT AND C. F. HEMPSTEAD. *Phys. Rev.*, **94**, 1593–600 (*June* 15, 1954).

The theoretical expressions for the anomalous dispersion of X-rays have been integrated for any positive value of p_q in a $C_q\lambda^{p_q}$ term in the distribution of "dispersion" oscillators for the q shell of electrons. This distribution may be written generally as the sum of n terms of the form $C_{qn}\lambda^{p_{qn}}$ or, as is commonly done, as a single term. Damping has been retained, its effect evaluated and shown to be negligible except for λ extremely close to the wavelength of an absorption discontinuity. With damping neglected, universal dispersion curves are presented. If p_q and g_q (the oscillator strength) are known, the anomalous part of the refractive index or of the atomic scattering factor can be readily deduced from the universal curves. Comparison of the more exact theoretical values with experiment shows less satisfactory agreement than before. A.

537.531 : 535.331

8324. Soft X-ray emission bands in metals. H. JONES. Letter in *Phys. Rev.*, **94**, 1072 (*May* 15, 1954).

Comparison of the expressions for the additional term in the bandwidth due to exchange, calculated on the basis of (i) the Hartree–Fock theory, (ii) the Bohm–Pines theory [Abstr. 1278 (1954)], (iii) a screened potential of the form $e^{-\lambda r}/r$. E. H. SONDHEIMER

537.531 : 535.343

8325. A study of the X-ray absorption spectra of zinc in solutions. K. I. NARBUTT. *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 208–23 (1954) *In Russian.*

An account is given of the results of an experimental study of the X-ray K absorption spectra of zinc solutions. A focusing bent-crystal vacuum spectrograph was employed with reflection from the $10\bar{1}0$ plane of a quartz crystal. The thickness of the solution used was such as to give an equivalent thickness of 4·6 microns of Zn. The dispersion was 4·23 X units/mm. Solutions in nitric, sulphuric and acetic acids and solutions of zinc chloride and bromide showed slight changes in the fine structure but the wavelength of the absorption maximum did not change. The observed spectrum is well accounted for by postulating a hydrogen-like model for the Zn^{++} ion and this leads to values for the positions of separate lines in agreement with corresponding values for the terms of Ga III. Variation of the concentrations from 0·5 to 6·7 N has no influence on the general form of the lines but causes small displacements. Changing the solvent causes a change in the width of the main maximum, displacement of the broad diffuse maximum, and a change in the distances between the main successive maxima. A relation is found between the width of the main maximum and the dipole moment of the molecule in solution. The spectra from $Zn(OH)_2$, $Zn(NH_3)_6^{++}$, $Zn(OH)_4''$, and $Zn(CN)_4''$ show definite connections with the ion type and some explanation is proposed. Freezing of the solution is accompanied by strong splitting of the energy levels which occurs in several intermediate steps. A. L. MACKAY

537.531 : 535.343

8326. Fine structure of X-ray absorption spectra in homopolar crystals. A. N. NIGAM. Letter in *Curr. Sci.*, **23**, 117–18 (*April*, 1954).

A tentative mathematical approach to an understanding of the differences observed in the fine structure of the spectra of the constituent atoms of homopolar crystals. A. D. LE CLAIRE

537.531 : 535.343

8327. Absorption spectrum of beryllium in the neighborhood of the K edge. R. W. JOHNSTON AND D. H. TOMBOULIAN. *Phys. Rev.*, **94**, 1585–9 (*June* 15, 1954).

The absorption spectrum of metallic Be has been investigated in the soft X-ray region extending from 60 Å to 250 Å. The K discontinuity appears at 111 Å and coincides with the K edge observed in the emission spectrum. Over the spectral range studied, the values of the linear absorption coefficient range from $0{\cdot}25\times10^5$ to $2{\cdot}8\times10^5\ cm^{-1}$. Characteristic secondary structure is also noticeable on the short wavelength side of the edge. The positions of secondary absorption maxima are compared with those previously found in the K absorption spectrum of Al and with theoretical calculations based on the Hayasi model. The absorption spectrum has also been studied by irradiating Be absorbers with the continuous far ultraviolet radiation emitted by relativistic electrons accelerated in the Cornell synchrotron. Partial reduction of the data indicates good agreement with determinations based on the use of line spectra as the incident radiation. A.

537.531 : 535.345 : 532.7

8328. The attenuation of X-rays in highly compressed liquid materials. W. SCHAAFFS. *Z. Phys.*, **137**, *No.* 2, 200–6 (1954) *In German.*

Measurements of the density in a shock wave in a liquid by the attenuation of X-rays passing through it give values considerably greater than those calculated from geometrical considerations. It is shown that the attenuation of X-rays in these circumstances depends not only on the total mass traversed but also on the ratio of the actual to the effective volumes of the molecules. A. E. DE BARR

537.531 : 621.386.1

8329. Construction and technical features of high-vacuum impulse X-ray tubes. W. SCHAAFFS AND K. H. HERRMANN. *Z. angew. Phys.*, **6**, *No.* 1, 23–35 (1954) *In German.*

A detailed study of tubes for operation at 40–400 kV for high-speed photography and metallurgical studies. Rating is expressed in thickness of steel effectively penetrated by a single impulse: for 400 kV this is ~ 10 cm, for 175 kV, 2 cm, and for 100 kV, 0·6 cm. Pulse lengths are 0·01–1 μsec. The dependence of output on capacitance and inductance of discharge circuit as well as on cathode design is discussed, and focal spot diameters of 0·2–0·3 cm are achieved in practice. F. T. FARMER

537.531 : 621.386.1

8330. A variant of the fine-focus X-ray tube with regulated focal spot dimensions. B. YA. PINES AND E. Z. MAZEL'. *Zh. tekh. Fiz.*, **24**, *No.* 2, 326–8 (1954) *In Russian.*

The X-ray tube described earlier [Abstr. 2066 (1953)] has been improved by the replacement of the sylphon bellows, which allowed the filament to be moved, by an internally threaded washer which gives a steadier motion and finer control. The spot area has been reduced to $6\times10^{-3}\ mm^2$ giving a loading of $10\ kW/mm^2$. The beam leaves the anode surface almost normally and the focal spot can be located on the circumference of a 114·4 mm dia. focusing camera. A. L. MACKAY

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 615.849.1 : 621.384.62

8331. An 8-MeV linear accelerator for X-ray therapy. C. W. MILLER. *Proc. Instn Elect. Engrs I*, **101**, 207–22 (*July*, 1954).

For abstract, see Abstr. 4583 (1954).

537.533 : 621.384.62

8332. Improvement in performance of a linear accelerator by bunching the electrons before injection. M. PAPOULAR. *C.R. Acad. Sci.* [*Paris*] **238**, 789–91 (*Feb.* 15, 1954) *In French.*

Theoretical results are quoted for an electron accelerator whose wave-velocity is that of light, although the particle injection-velocity may be much lower. The fraction of particles accelerated and their

final energy spread are found to be much improved by pre-bunching about the optimum injection phase.

J. S. BELL

537.533 : 621.384.62

8333. Construction of a linear electron accelerator with pre-bunching. M. PAPOULAR. *C.R. Acad. Sci. [Paris]* **238,** 1115–17 (*March* 8, 1954) *In French.*

A separate accelerating gap was used to pre-bunch the particles in phase. This doubled the number of particles reaching the maximum energy in a 1 MeV accelerator. J. S. BELL

537.533.2

8334. Concerning the work function of electrons at the surfaces of a single crystal of nickel. R. ASADULLIN AND G. N. SHUPPE. *Zh. tekh. Fiz.*, **24,** *No.* 2, 205–15 (1954) *In Russian.*

Considered first from a crystallographic point of view and a comparison of nickel with tungsten. Then experimentally observed in an emission picture given by a spherical electron projector using a nickel point as the source, and also with layers of nickel on plates of NaCl. It is concluded that $\phi_{111} > \phi_{100} = 4{\cdot}9$ eV $> \phi_{\text{poly-Ni}} = 4{\cdot}6$ eV, $\phi_{111} \gg \phi_{100} = 4{\cdot}9$ eV $\gg \phi_{110} > \phi_{113}$, and that quantitative observations of emission from separate faces at the nickel point is impossible because of the mobility of the Ni atoms.

W. BARDSLEY

537.533.2

8335. On the electron emission from cold metal surfaces at medium field strengths. K. KERNER AND H. RAETHER. *Z. angew. Phys.*, **6,** *No.* 5, 212–13 (1954) *In German.*

Measurements were made with fields of $\sim 10^4$ V/cm and pressures $< 10^{-5}$ mm Hg using a counter tube to measure the current. The emission depended strongly on the state of the cathode, being e.g. reduced by 2–3 order of magnitude by running a gas discharge between the electrodes. The data were fitted to Schottky lines and gave work functions of 1–2 eV. A. H. W. BECK

537.533.331 : 621.385.832

8336. The adjustment of electron-optical filter lenses. O. RANG. *Optik*, **11,** *No.* 7, 327–34 (1954) *In German.*

The development of electron optics has led to the use of more complicated lens systems. The paper discusses the adjustment and use of electrostatic filter lenses of the type described in previous papers [Abstr. 1047 (1952)]. A.E.I. RESEARCH LABORATORY

537.533.35 : 621.385.833

8337. The theory and practice of electron microscope stereo pictures. J. G. HELMCKE. *Optik*, **11,** *No.* 5, 201–25 (1954) *In German.*

Discusses the requirements that must be satisfied in the taking and reproducing of stereo images. The important factors are the stereo-angle in the electron microscope, the depth of the object and the magnification. In the optical reproduction, the optical constants and magnification of the projector system is important, as are the general conditions of viewing. The paper includes useful practical advice on projecting stereo-images for a fairly large audience.

A.E.I. RESEARCH LABORATORY

537.533.35 : 621.385.833 : 535.371.07

Comparative measurements on electron-excited viewing screens in transmission and reflection. *See Abstr.* 8192

537.533.35

8338. A 30 cm double focusing magnetic spectrometer with an annular iron yoke. P. H. STOKER, ONG PING HOK, E. F. DE HAAN AND G. J. SIZOO. *Physica*, **20,** 337–49 (*June*, 1954).

Theory shows that the highest luminosity in a β-spectrometer at a certain resolution can be obtained, when the field in the equatorial plane at a distance r from the centre fulfils the condition $H_z(r, 0) = [1 - \frac{1}{2}\rho + \frac{3}{8}\rho^2 - \frac{5}{24}\rho^3 + \frac{37}{192}\rho^4 - \ldots]$ where r_0 is the radius of the principal orbit of the electrons and $\rho = (r - r_0)/r_0$. This is practically identical with a field represented by $H(r) = H(r_0)\,(r_0/r)^{\frac{1}{2}}$. The equipotential surfaces in such a field corresponding with the surface of the pole shoes, have been calculated numerically. A β-spectrometer has been constructed realizing this field. The value of r_0 is 30·0 cm; the maximum transmission 2·8%; using a source of 1·0 cm width the half-value width for a mono-kinetic electron line was found to be 2·5%. To reduce the stray-field an annular yoke is used, surrounding the airgap as well as the coils. The magnetic field is measured by a compensation method. The experimental arrangement is described and the results of some measurements are given. A.

537.533.74

8339. Elastic scattering of electrons on an extended nucleus at intermediate energies. E. FREESE AND K. HAIN. *Z. Naturforsch.*, **9a,** 456–62 (*May*, 1954) *In German.*

The effect of the finite size of the nucleus, Hg, in the 0–30 MeV region is calculated for a uniform and for a surface charge distribution. P. T. MATTHEWS

537.533.74

8340. Inelastic scattering of 190-MeV electrons in beryllium. J. A. MCINTYRE, B. HAHN AND R. HOFSTADTER. Letter in *Phys. Rev.*, **94,** 1084–5 (*May* 15, 1954).

Two electron groups lower in energy than those elastically scattered were found to correspond to the excitation of the well-known 2·5 and 6·8 MeV levels in Be. The angular distribution of the inelastically scattered electrons is flatter than that for the elastic scattering. J. HUGHES

537.533.74

8341. The energy distribution of back-scattered electrons. H. KULENKAMPFF AND W. SPYRA. *Z. Phys.*, **137,** *No.* 4, 416–25 (1954) *In German.*

Using a counter-field method the numbers of back-scattered electrons were measured for Al, Cu, Ag and Pt, bombarded at 90° and 45° by 20, 30 and 40 keV electrons. A somewhat slower increase with Z was found than Schonland's [*Proc. Roy. Soc. A*, **108,** 187 (1925)]. By differentiation, energy spectra were deduced showing a maximum at small energy losses, and a long tail at larger losses. With increasing Z, and decreasing angle the maximum moves nearer the incident energy. W. J. SWIATECKI

537.533.74

8342. The energy and angular distribution of back-scattered electrons. H. KULENKAMPFF AND K. RÜTTIGER. *Z. Phys.*, **137**, *No.* 4, 426–34 (1954) *In German.*

These were determined at 97, 117 and 137° using the same apparatus, elements and energies as in the preceding abstract, and normal incidence. With increasing scattering angle the energy spectra become broader and their maxima move to smaller energies. The number of back-scattered electrons tends to a $\cos\theta$ law for larger Z, and falls below this for smaller Z and large angles. W. J. SWIATECKI

537.533.75

8343. Electron straggling in thin foils. E. T. HUNGERFORD AND R. D. BIRKHOFF. *Phys. Rev.*, **95**, 6–7 (*July* 1, 1954).

A recent experimental investigation of electron straggling distributions reports disagreement with the distribution half-widths of the Landau–Blunck–Leisegang theory. Additional experimental work has been performed in which the angle of incidence of radiation on the foil has been more carefully controlled and a different method of comparison of theory and experiment has been employed. Discrepancies noted in the previous work with light elements are no longer found. A.

537.533.75 : 537.534.75 : 539.185.7 : 530.162

Application of Markov's method to sequences of energy losses. *See Abstr.* 8073

537.533.8

8344. The angular distribution of the secondary electrons of soot. J. L. H. JONKER. *Philips Res. Rep.*, **8**, 434–40 (*Dec.*, 1953).

The angular distribution of the secondary electrons of soot is measured with the same equipment as was used before to measure polycrystalline nickel [Abstr. 1870 (1952)]. The results for soot and for nickel are compared with each other. A.

537.533.8

8345. Energy and temperature dependence of the secondary emission of MgO. A. J. DEKKER. *Phys. Rev.*, **94**, 1179–82 (*June* 1, 1954).

It is shown that the data on the energy and temperature dependence of the secondary yield of magnesium-oxide single crystals, recently published by Johnson and McKay [Abstr. 7724 (1953)] can be understood on the basis of a simple model. In fact, quantitative agreement is obtained for the temperature coefficient of the yield. The importance of measurements far away from either side of the maximum of the yield curve is stressed. A.

537.533.8

8346. Theory of secondary electron cascade in metals. P. A. WOLFF. *Phys. Rev.*, **95**, 56–66 (*July* 1, 1954).

A study is made of the cascade process which describes the diffusion, energy loss, and multiplication of secondary electrons within a metal. The secondaries interact mainly with conduction electrons through a screened Coulomb potential. For low secondary energy (< 50 eV) the resultant scattering is nearly spherically symmetric and the transport equation which governs the cascade process can be approximately solved. The velocity distribution turns out to be spherically symmetric for low secondary energy. Energy distributions are in agreement with experiment for metals to which the theory is applicable. Calculations are also made of the rate of change of yield with work function and the results are in accord with observed values. Finally, rough estimates are made of the total yield and the theory is shown to be consistent with the observed values. A.

537.533.8

8347. Polarization of röntgen-bremsstrahlung from a thin anticathode. H. KULENKAMPFF, S. LEISEGANG AND M. SCHEER. *Z. Phys.*, **137**, *No.* 4, 435–44 (1954) *In German.*

This was determined by measuring the range and angle of projection of photoelectrons from the K-shell of A produced by the radiation in a cloud chamber. For a thin Al anticathode and a potential of 34 kV, agreement was obtained between the experimental results and the degree of polarization predicted from Sommerfeld's theory of bremsstrahlung. J. HUGHES

537.533.8

8348. On the energy distribution in the spectrum of röntgen bremsstrahlung. R. FUCHS AND H. KULENKAMPFF. *Z. Phys.*, **137**, *No.* 5, 583–7 (1954) *In German.*

The approximate expression $J_\nu = \text{const.}\,(\nu_{\max} - \nu)$ obtained by Kulenkampff and Schmidt [*Ann. Phys.* (Leipzig), **43**, 494 (1943)] was shown to be invalid as the frequency dependence of the reflection coefficient of the spectrometer crystal had been neglected. The simple relation was restored when a correction was made for the backscattering of the electrons from the anticathode. J. HUGHES

537.533.9

8349. On the quantum theory of a luminescent electron. II. A. A. SOKOLOV, N. P. KLEPIKOV AND I. M. TERNOV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 249–52 (1953) *In Russian.*

In continuation of Pt I [Abstr. 528 (1954)], the authors find the total intensity of radiation, assuming $n/l \ll 1$. The final equation is

$$W = \frac{2}{3}\frac{e^2\omega_0^2}{c}\left(\frac{E}{mc^2}\right)^4\left[1 - 55\frac{\sqrt{3}}{16}\left(\frac{\hbar}{mcR}\right)\left(\frac{E}{mc^2}\right)^2 + \cdots\right],$$

where R = radius of classical orbit, and E = electron energy. [See also Abstr. 8224 (1953)]. F. LACHMAN

537.533.92

8350. Investigations into the ionizing action of fast electrons. R. DECHER AND H. KULENKAMPFF. *Z. Phys.*, **137**, *No.* 5, 638–48 (1954) *In German.*

The measurements were made with 4·9 MeV electrons. The total specific ionization N_t in air was determined using an ionization chamber and collector, and the primary specific ionization N_p was determined from cloud chamber photographs. At N.T.P., $N_t = 62{\cdot}5\ \text{cm}^{-1}$ and $N_p = 25{\cdot}4\ \text{cm}^{-1}$. J. FRANKS

537.534

8351. Acceleration of heavy ions in the 225-cm cyclotron at the Nobel Institute of Physics. Preliminary note. H. ATTERLING. *Ark. Fys.*, **7**, *Paper* 43, 503–6 (1954).

The Stockholm cyclotron at a fixed frequency of

8·7 Mc/s has been used to accelerate $^{12}C^{6+}$, $^{14}N^{6+}$, $^{16}O^{6+}$, and other heavy multiple charged ions. The maximum energy attainable in MeV being 12·5 times the atomic weight. These high-energy particles have been used to induce activity. The methods used to strip the ions to the six-charged state are noted. A preliminary study of the $^{20}Ne^{9+}$ resonance has been made. W. T. BLACKBAND

537.534

8352. On focusing in a "standing-wave" accelerator. J. POTTIER. *C.R. Acad. Sci.* [*Paris*] **238,** 1795–7 (*May* 3, 1954) *In French.*

A suitable arrangement of drift-tubes in a proton linear accelerator will ensure both radial focusing and phase stability. P. A. STURROCK

537.534

8353. On the use of intense particle beams for the excitation of gases. A. E. GRÜN, E. SCHOPPER AND B. SCHUMACHER. *Z. angew. Phys.*, **6,** *No.* 5, 198–200 (1954) *In German.*

Briefly describes apparatus for the production of ion beams at energies ~ 600 keV and proceeds to show a system for the excitation of an atom beam, issuing from a suitable nozzle, by electrons. Afterglow in the gas atom beam enables various jet phenomena to be followed. J. D. CRAGGS

537.534 : 621.384.6

8354. The sector-profiles of the strong-focusing cosmotron in the case of small-diameter machines. G. SASSON. *C.R. Acad. Sci.* [*Paris*] **238,** 885–8 (*Feb.* 22, 1954) *In French.*

The magnetic scalar potential is represented by one, or a combination, of certain accurate solutions of Laplace's equation in cylindrical co-ordinates. The equipotentials give possible pole-face shapes. Calculations are made for a machine of 86 m radius with field index 400, and for one of 2 m radius with field index 10. For the large machine the pole-faces differ little from rectangular hyperbolae, but for the smaller machine the difference is considerable. The variation of field-index over the aperture is also considered. J. S. BELL

537.534 : 621.384.6

8355. The orbit instabilities due to coupling between the radial and vertical betatron oscillations in the cosmotron. J. SEIDEN. *C.R. Acad. Sci.* [*Paris*] **238,** 1010–12 (*March* 1, 1954) *In French.*

The coupling is caused by machine imperfections. The kinds of imperfection considered are described as random rotations of the magnets and azimuthal inhomogeneities of the field. Instability is predicted when the sum of the numbers per revolution of radial and vertical oscillations is integral. J. S. BELL

537.534 : 621.384.62 : 621.372.8

8356. A helical waveguide for accelerating protons from 1 MeV to 10 MeV. R. SERVRANCKX. *Bull. Acad. Roy. Belgique Cl. Sci.*, **40,** *No.* 2, 167–78 (1954) *In French.*

The proposed guide consists of a helix and a concentric outer conductor. The fields are discussed by idealizing the helix as a uniform sheet conducting in one direction only. Assuming the power to be constant along the guide, and using the equation of longitudinal motion for the synchronous particle, the pitch is determined as a function of position along the machine; this is tabulated for a specific design which has a wavelength of 1·5 m, helix radius 2 cm, outer cylinder radius 4·5 cm and initial peak axial field 33 kV per cm. Calculations are in progress which take account of power loss. It is hoped to dispense with external focusing devices by using the fact that some particles performing rather large phase oscillations will receive from the wave a force which is on the average inwards. A section of guide has been made, and experiments with it are in satisfactory agreement with the theoretical frequency to phase-velocity relation. J. S. BELL

537.534.3

8357. On the image contrast in proton-microscopy due to the elastic and inelastic scattering of the protons in the light elements. P. CHANSON AND C. MAGNAN. *C.R. Acad. Sci.* [*Paris*] **238,** 1701–3 (*April* 26, 1954) *In French.*

The note gives a comparison between the contrast resulting from elastic and inelastic scattering in the electron and proton microscopes. Elastic scattering results in appreciably greater contrast with proton radiation while inelastic scattering gives greater contrast for electron radiation. These results are deduced from the Born approximation in the scattering theory. A.E.I. RESEARCH LABORATORY

537.534.3

8358. Further contrast source in images obtained with the proton microscope. P. CHANSON AND C. MAGNAN. *C.R. Acad. Sci.* [*Paris*] **238,** 1797–9 (*May* 3, 1954) *In French.*

The contribution to contrast which can be expected from electron capture and loss reaction between protons and the object in the proton microscope is discussed. It is shown that organic objects 50 Å thick would result in a neutralization of the charge in about 50% of the beam protons. M. E. HAINE

537.534.74

8359. Proton polarization at ~ 130 MeV. J. M. DICKSON AND D. C. SALTER. Letter in *Nature* [*London*] **173,** 946–8 (*May* 15, 1954).

The beam from the Harwell cyclotron was scattered first from a carbon target, then from carbon, uranium or hydrogen second targets. For the carbon and uranium second targets, the polarization showed a sharp maximum for the elastically scattered protons, decreasing with the energy loss for inelastically scattered protons. G. E. BROWN

537.534.75

8360. Measurements of proton range-straggling in nuclear emulsions. KWEE KIEM HAN AND P. M. ENDT. Letter in *Physica*, **20,** 311–12 (*May*, 1954).

Measurements on 1·7 MeV–8·9 MeV proton groups from (d, p) reactions are reported. J. J. WILKINS

537.534.75

8361. Range and specific ionization for high-energy protons in nuclear emulsions. O. HEINZ. *Phys. Rev.*, **94,** 1728–31 (*June* 15, 1954).

Stacks of nuclear emulsion varying in thickness

from 18·35 g/cm² to 56·83 g/cm² were exposed in the external proton beam of the Berkeley cyclotron, and the average specific ionization dT/dx [in MeV $(g/cm^2)^{-1}$] was measured by determining the equivalent thickness of Cu needed to remove the same amount of energy from the beam as a given thickness of emulsion. The energies range from 230 to 320 MeV. The emulsion stacks consisted of layers of 200 μ Ilford C-2 stripped emulsions of average density $3·81 \pm 0·01$ g/cm³. The specific ionization was found to be 1·5% higher for emulsion than for Cu measured over the same energy interval. From these data the ratio of the mean ionization potentials for emulsion and Cu was determined as $I_E/I_{Cu} = 0·89 \pm 0·09$. The range of 342·5 MeV protons in emulsion was found to be $92·68 \pm 0·25$ g/cm², which is 1·1% lower than the measured range of the same beam in Cu ($93·65 \pm 0·20$ g/cm²). The measured range in emulsion is about 1·5% shorter than the value calculated by Vigneron (and extended to higher energies by Barkas). They assumed 332 eV as the mean ionization potential of emulsion. A.

537.534.79

8362. The state of ionization of fast nitrogen ions passing through matter. K. G. Stephens and D. Walker. Letter in *Phil. Mag.*, **45**, 543–5 (*May*, 1954).

Direct measurements have been made of the relative probabilities of various states of ionization of 15 MeV N^{14} ions accelerated in the Birmingham cyclotron. A narrow defined external beam of $^{14}N^{2+}$ ions was passed through an organic film 0·1 μ thick, analysed by the fringing magnetic field and allowed to fall on a nuclear emulsion. Track counts gave the relative probabilities of 3+, 4+, 5+, 6+ and 7+ states as 0·4%, 6%, 45·6%, 40·5% and 7·5% corresponding to a mean charge of 5·49. J. H. FREMLIN

537.534.8

8363. Secondary emission from Nichrome V, CuBe, and AgMg alloy targets due to positive ion bombardment. M. J. Higatsberger, H. L. Demorest and A. O. Nier. *J. appl. Phys.*, **25**, 883–6 (*July*, 1954).

A mass spectrometer ion collector system has been devised for the investigation of secondary electron emission by impact of ions on surfaces. Results are reported for various ions incident on clean, baked (but not atomically clean) surfaces of AgMg, CuBe, and Nichrome V targets. For rare gas isotopic ions it is found that for a given energy ion the value of γ varies approximately inversely with the square root of the mass. A.

537.534.9

8364. *L*-shell ionization by protons of 1·5- to 4·25-MeV energy. E. M. Bernstein and H. W. Lewis. *Phys. Rev.*, **95**, 83–6 (*July* 1, 1954).

Characteristic *L*-shell X-rays produced when protons of 1·5 to 4·25 MeV energy are stopped in Ta, Au, Pb, and U have been studied with a NaI scintillator. The absolute cross sections for X-ray production are presented. By correcting these values for Auger transitions, the *L*-shell ionization cross-sections have been determined. At 3 MeV, the X-ray production cross-sections are 104, 74, 54, and 24 barns for Ta, Au, Pb, and U, respectively. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542 : 539.164.08

Precision alpha-particle counting. *See Abstr.* 8580

537.542

8365. Dependence of the efficiency of counters on overvoltage. A. O. Vaĭsenberg and V. G. Kirillov-Ugryumov. Letter in *Zh. éksper. teor. Fiz.*, **24**, *No.* 1, 124–5 (1953) *In Russian.*

Presents graphed results of tests conducted with He, and A, self-extinguishing counters [with C_2H_5OH vapours, see also Abstr. 3201 (1950)] arranged in "telescopes." The dependence of the number of coincidences on overvoltage (or on the pulse on the filament) was determined. While for the A counters the number of coincidences is practically independent of overvoltage, a pronounced relationship is observed for He counters. An explanation of the findings is given. F. LACHMAN

537.542

8366. On the lengthening of the plateau of Geiger–Müller counters with glass cathodes. S. Michalak, B. Mowczan and A. Zawadzki. *Acta phys. Polon.*, **13**, *No.* 2, 145–9 (1954) *In French.*

Gives, in considerable detail, counting characteristics for Maze counters (external cathode). The effects of temperature (methylal–argon fillings were used), and circuit resistance are demonstrated.

J. D. CRAGGS

537.542

8367. Temperature variations of the characteristics of vapour-filled Geiger–Müller counters. H. J. Mader. *Z. Phys.*, **137**, *No.* 2, 216–27 (1954) *In German.*

The plateau characteristics of counters filled with self-quenching mixtures (e.g. argon, organic vapours) show large variations with temperature and with time. These effects are shown graphically and the results are discussed qualitatively, with reference to temperature variations of partial pressure of quenching vapour, adsorption effects, etc. J. D CRAGGS

537.542

8368. The gas discharge mechanism of Geiger counters filled with halogen–rare-gas mixtures. D. van Zoonen. *Delft: Technische Hogeschool* (1954) 132 *pp. In Dutch.* Summary (5 *pp.*) *in English.*

This detailed thesis deals with the gaseous discharge physics of halogen quenched counters. The techniques, such as the manipulation and pressure measurements of the halogens are described. The general discharge mechanisms are dealt with in detail. The experiments with Geiger counters are very comprehensive and include studies of discharge propagation velocities, X-ray counting efficiencies, and build-up mechanisms. The normal theories of pulse formation do not apply (because of electron capture and the greater radial size of the multiplication region) and this situation is discussed in detail. Finally, the advantages and disadvantages of halogen fillings are discussed. J. D. CRAGGS

537.542 : 621.387.424

8369. The counting loss of a Geiger counter with periodic arrival rate of quanta. F. K. du Pré. *Philips Res. Rep.*, **8**, 411–18 (*Dec.*, 1953).

A formula is derived for the counting loss of a

Geiger counter with arbitrary dead time, exposed to periodic X-radiation of arbitrary wave-form. An "extended" dead time is assumed. In particular, the small-loss case is considered since then the results are independent of the type of dead-time mechanism. The small-loss corrections obtained by different authors are shown to be special cases of the general formula. A.

537.542

8370. Use of dissolved acetylene in liquid scintillation counters for the measurement of carbon-14 of low specific activity. B. N. AUDRIC AND J. V. P. LONG. Letter in *Nature* [*London*] **173,** 992–3 (*May* 22, 1954).

537.542 : 539.166.08

8371. A two-crystal gamma ray scintillation spectrometer. D. H. PEIRSON. Letter in *Nature* [*London*] **173,** 990–1 (*May* 22, 1954).

An anthracene crystal scintillation counter and a sodium iodide crystal scintillation counter are exposed to the same γ-ray source and the Compton distribution from the anthracene system used to cancel that from the sodium iodide system leaving only the photoelectric energy peaks in the pulse distribution from the latter. The arrangement allows good geometry and high sensitivity with no loss of resolution. G. F. J. GARLICK

537.542 : 539.185.08

8372. Fast-neutron scintillation survey meter. B. W. THOMPSON. *Nucleonics,* **12,** 43–5 (*May*, 1954).

Neutrons are detected by the recoil protons, from a thick polyethylene radiator, falling on to a ZnS(Ag) scintillation screen. The polyethylene is in the form of a hollow sphere coated inside with the phosphor, with an end window photomultiplier directed through a hole in the surface to detect the light pulses. The device actually measures the neutron energy flux above a minimum energy which is set by the requirement of discrimination against γ-ray background. Choice of a spherical shape is based on the need for non-directional sensitivity. L. R. SHEPHERD

537.542 : 621.317.79 : 621.387.46

8373. Logarithmic d.c. ratemeters for scintillation counters. H. D. LEVINE. *Nucleonics,* **12,** 36–9 (*Feb.*, 1954).

A logarithmic response, over 5 decades or more, is obtained by making use of the relationship between anode current and grid current in a directly heated sub-miniature pentode (triode-connected). The grid of the tube is connected to the 10th dynode of an 11 stage photomultiplier which is used in conjunction with a large NaI (Tl) or plastic phosphor. Circuit details of a survey meter, having a good logarithmic response over a range of radiation levels from 0·001 r/hr to 10 r/hr, are given. L. R. SHEPHERD

537.542 : 621.374.32

8374. Dead-time losses in multichannel coincidence systems. J. S. KIRKALDY. *Canad. J. Phys.*, **32,** 406–15 (*June*, 1954).

Correction formulae for the counting losses due to dead-times in multichannel coincidence systems are derived for conditions of significant interchannel correlation and for both continuous and pulsed sources of counts. The dead-times are assumed to be either "extending" (following all counts) or "nonextending" (following only recorded counts). The corrections for the effects of a finite coincidence resolving-time are also evaluated. The approximations used are shown to be valid when the fractional losses are less than 40%, by comparison with the results of a previous experimental paper. The corrections are most likely to be required in the case where the source is intermittent, as from a pulsed accelerator, so that the instantaneous counting rates are very high during the pulse, and where the coincidence rate is of the same magnitude as the non-coincident rates, as in a well-shielded coincidence telescope. A.

537.542 : 621.385.12 : 621.374.32

8375. A scaling unit employing multi-electrode cold-cathode tubes. K. KANDIAH. *Proc. Instn Elect. Engrs II,* **101,** 227–38 (*June*, 1954).

For abstract, see Abstr. 6895 (1953).

537.542 : 621.392 : 621.38

8376. The calculation of linear, realizable networks for the attainment of optimum signal-to-noise ratios. K. HALBACH. *Helv. phys. Acta,* **26,** *No.* 1, 65–74 (1953) *In German.*

The characteristics of the signal and background noise are assumed to be known and the duration of the measurement is arbitrary. As a concrete example the optimum ionization chamber amplifier is discussed and is compared with the network whose h.f. and l.f. characteristics are both determined by RC-networks and with delay line clipping.

A. H. W. BECK (R)

537.542

8377. Stereoscopic reprojection and radius of curvature measurements of cloud chamber tracks. C. R. EMIGH. *Rev. sci. Instrum.*, **25,** 567–9 (*June*, 1954).

A means of accurately and rapidly measuring the radii of curvature of many cloud-chamber tracks is described. The apparatus includes a photographing-reprojecting system and a curvature-measuring device. This device is capable of measuring radii of reprojected tracks in the range from 0·5 cm to 100 cm with the poorest accuracy of the order of 3% occurring at 100 cm. A.

IONIZATION . THERMIONICS 537.56/.58

537.56

8378. Collisional effects and the conduction current in an ionized gas. A. A. WARE. Letter in *Phil. Mag,* **45,** 547–9 (*May*, 1954).

Comparison of the current transport equation for a binary ionized gas in a large magnetic field obtained by Westfold [Abstr. 8478 (1953)] with previous theoretical considerations for particular cases by Davydov [*Physikalische Zeitschrift der Sowjetunion,* **12,** *No.* 3, 269–300 (1937)] and Landshoff [Abstr. 794 (1950)], leads to the conclusion that Westfold's expression for the collisional term in the transport equation is a good approximation only for isothermal plasmas. J. DUTTON

537.56 : 532.65

8379. Ionization by the break-up of drops in an electric field. V. M. MUCHNIK. *Zh. éksper. teor. Fiz.*, **26**, *No.* 1, 109–14 (1954) *In Russian.*

An experimental study of water drops of 0·6 cm diameter in a vertical stream of air in a field of the order of 170 V/cm. On breaking-up ions were formed and were registered as light and heavy ions by an electrometer. For the break-up of one drop 10^5 light ions and $2{\cdot}1\times10^9$ heavy ions were formed; the corresponding total charges were -5×10^{-5} and $-1{\cdot}0$ e.s.u. Experiments were also performed on the variation of the charge produced as a function of the field and it was shown to be directly proportional to the applied field. J. M. HOUGH

537.561

8380. Electron-impact studies in CH_4, CH_3Cl, CH_3Br and CH_3I. H. BRANSON AND C. SMITH. *J. Amer. Chem. Soc.*, **75**, 4133–8 (*Sept.* 5, 1953).

Data on the appearance potentials of the positive ions produced on electron impact with CH_4, CH_3Cl, CH_3Br and CH_3I in a 60° Nier type mass spectrometer are used to calculate the heat of sublimation of carbon, $L(C) \leqslant 5{\cdot}90$ eV. Further calculations from the data give $D(C\text{–}H) = 3{\cdot}5$ eV, $D(C\text{–}2H) \leqslant 7{\cdot}4$ eV, $D(C\text{–}3H) \geqslant 11{\cdot}2$ eV, $D(CH_3\text{–}H) \leqslant 4{\cdot}2$ eV, $D(CH_3\text{–}Cl) \leqslant 3{\cdot}4$ eV, $D(CH_3\text{–}Br) \leqslant 3{\cdot}1$ eV, and $D(CH_3\text{–}I) \leqslant 2{\cdot}3$ eV. The measured ionization potentials are $I(CH_4^+) = 13{\cdot}1$ eV, $I(CH_3Cl^+) = 11{\cdot}3$ eV, $I(CH_3Br^+) = 10{\cdot}5$ eV, and $I(CH_3I^+) = 9{\cdot}6$ eV. The derived $I(CH_2^+)$ is $\leqslant 12$ V. A.

537.561 : 539.132

8381. The ionization potentials and electronic structures of methyl and ethyl fluoride. C. A. MCDOWELL AND B. C. COX. Letter in *J. chem. Phys.*, **22**, 946 (*May*, 1954).

As a consequence of Mulliken's theory of the structure of alkyl halides in terms of localized orbitals, the ionization potential of CH_3F should be nearly equal to that of CH_4, and that of C_2H_5–F to that of C_2H_6. Good agreement with this prediction has been obtained from experiments by the electron impact method in a mass spectrometer. A. J. TAYLOR

537.563

8382. Negative ion formation in CCl_4 and $TiCl_4$. J. MARRIOTT, R. THORBURN AND J. D. CRAGGS. Note in *Proc. Phys. Soc.* [*London*] *B*, **67**, 437–8 (*May*, 1954).

A brief summary of experiments designed to aid in the identification of negative ion forming processes in certain electronegative gases. J. D. CRAGGS

537.564

8383. Energy thresholds for the decomposition of heavy negative ions in collisions with helium atoms. V. M. DUKEL'SKIĬ AND É. YA. ZANDBERG. *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 339–41 (1953) *In Russian.*

See Abstr. 5867 (1952). Results are graphed and tabulated of experiments with ions Te^-, Te_2^-, Bi^-, and Sb_2^- [for apparatus see Abstr. 8806 (1951)]. The following energy threshold values (in He gas at a pressure of 10^{-3} mm Hg) have been determined: Te^-, 180; Te_2^-, 340; Sb_2^-, 200 eV; the value obtained for Bi^- is uncertain. It is suggested that the threshold for the decomposition is determined by the energy W_0 required to bring the ion, in the case of central collision, to the critical distance r_0 from the atom; W_0 should be greater than S (the bonding energy of the excess electron). F. LACHMAN

537.564

8384. Negative ions in the dissociation of HCl and HBr by electron impact. H. GUTBIER AND H. NEUERT. *Z. Naturforsch.*, **9a**, 335–7 (*April*, 1954) *In German.*

These were examined mass-spectrometrically using bombarding energies 0–135 eV. Due to electron-capture processes well-defined intensity maxima appear at low energies with appearance potentials of $0{\cdot}8 \pm 0{\cdot}3$ eV for Cl^- and $0{\cdot}6 \pm 0{\cdot}3$ eV for Br^-, in agreement with simple energy balance considerations. A 2nd weaker maximum was observed at somewhat higher energies. W. J. SWIATECKI

537.564

8385. Mass-spectrometric investigations of CH_2Br_2, CH_2Cl_2, CH_3Br and CH_3Cl. H. GUTBIER. *Z. Naturforsch.*, **9a**, 348–50 (*April*, 1954) *In German.*

Singly ionized fragments resulting from the bombardment of the above molecules with 90 eV electrons were identified and the relative intensities determined (e.g. 22 fragments from CH_2Br_2, corresponding to different combinations of C, H and $Br^{79,81}$). Some 40 critical ionization and dissociation potentials (in the range 10–20 eV) were measured for the more intense lines. W. J. SWIATECKI

537.564

8386. Cross sections for charge transfer collisions of low-energy ions in N_2 and O_2. R. F. POTTER. *J. chem. Phys.*, **22**, 974–9 (*June*, 1954).

Measurements have been made of the cross-sections for charge transfer collisions between the low-energy (9–250 eV) ions, N_2^+, O_2^+, O^+ and N^+, and the molecules N_2 and O_2. Two reactions (N^+, N_2; O^+, N_2) have been reported by other workers and are compared with present work. The experimental method utilizes a radio-frequency mass spectrometer as an ion source. The ions are collimated and enter a weak radial electric field of cylindrical symmetry. The secondary ions are separated from the primary beam and the ratio of the two currents is measured as a function of pressure. Results are discussed in terms of the adiabatic collision condition and possible internal energy states of the ions and molecules. A.

537.564

8387. Alpha-particle ionization yields in a gridded chamber. L. O. HERWIG AND G. H. MILLER. *Phys. Rev.*, **94**, 1183 (*June* 1, 1954).

The energy per ion pair for natural uranium α-particles has been measured for several gases in a gridded parallel-plate ion chamber. Electron collection was used. The gases employed were He, Ne, A, Kr, N_2, A + 3% CO_2, and A + 5% N_2. On a relative basis, the results are in good agreement with those obtained by Jesse and Sadauskis using heavy ion collection. The absolute values herein reported are about 6% higher than those resulting from slow chamber measurements. A.

537.564

8388. Calculation of the energy per ion pair for α-particles in helium. G. A. ERSKINE. *Proc. Roy. Soc. A*, **224**, 362–73 (*July* 7, 1954).

The average energy per ion pair, W, for the ionization of helium by 1 to 6 MeV α-particles is calculated

using the Born approximation, the number of ion pairs produced by secondary, tertiary, etc., electrons being calculated from an integral equation which is solved numerically. The calculated W is nearly constant over this energy range, with average $W = 41{\cdot}1$ eV. This agrees well with the value, $W = 42{\cdot}7$ eV, measured by Jesse and Sadauskis [Abstr. 291 (1953)] for 5·3 MeV α-particles in helium, and supports their suggestion that the earlier measured values of W for α-particles in helium may have been spuriously low owing to the presence of small amounts of other gases. A.

537.565 : 539.133

8389. Interpretation of ionic mobilities in nitrogen. S. GELTMAN. Letter in *Phys. Rev.*, **94**, 1072 (*May* 15, 1954).

Shows, contrary to Johnson's interpretation [Abstr. 1144 (1951)], that polarization interaction and not quadrupole interaction is of primary importance in determining ionic mobility. J. DUTTON

537.581 : 548.7

8390. Work function and electron emission of non-metallic crystals. A. BOHUN. Letter in *Czech. J. Phys.*, **4**, 88 (*Feb.*, 1954) *In German.*

The photo- and thermionic electron emission of AgCl crystals after X-ray irradiation is studied for rising temperatures from 20° to 500°C, sharp maxima being observed with temperature rise. Results indicate a preponderance of centres of high dissociation energy (~2·5 eV) compared with others (~1·5 eV) in agreement with optical absorption measurements. G. F. J. GARLICK

537.583 : 621.38

8391. Physical basis of thermal noise. D. A. BELL. *Wireless Engr*, **31**, 48–50 (*Feb.*, 1954).

A simple demonstration of the derivation of the thermal noise formula from consideration of the electron mean free path and mobilities. It is considered that current engineering literature over-emphasizes the fact that Nyquist's derivation applies to a system in thermal equilibrium. The restriction to equilibrium conditions is, of course, unnecessary. A. H. W. BECK

COSMIC RAYS 537.591

537.591.1

8392. Determination of the mass of cosmic-ray particles from their ionizing power. A. I. ALIKHANYAN AND V. M. KHARITONOV. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 6, 1125–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-225.*

Describes the method of analysis used for determining the masses of particles of measured momentum from the ionization produced in a proportional counter. It is concluded that many cosmic-ray particles in the range between π-mesons and protons have masses of 531 and 910m_e. H. ELLIOT

537.591.1

8393. Low-momentum end of the spectra of heavy primary cosmic rays. R. A. ELLIS, JR, M. B. GOTTLIEB AND J. A. VAN ALLEN. *Phys. Rev.*, **95**, 147–59 (*July* 1, 1954).

Measurements of the intensity of heavy primary cosmic-ray nuclei have been made above the atmosphere by means of the new Iowa balloon-launched rocket ("rockoon") technique at geomagnetic latitudes $\lambda = 56°$, 76° and 86°. The measuring instrument was a thin-walled, pulse-ionization chamber of 15-cm diameter. The observed data, in conjunction with geomagnetic theory, demonstrate a complete or nearly complete absence of primary heavy nuclei of $Z \geqslant 6$ having a magnetic rigidity less than $1{\cdot}5 \times 10^9$ volts ($p/mc < 0{\cdot}8$), the result being the most significant for the C, N, O group. It is noted that this spectral cut-off occurs at closely the same magnetic rigidity, and distinctly not at the same velocity, as the previously reported cut-off in the spectra of primary protons and α-particles. A.

537.591.15

8394. The equilibrium energy spectrum of shower photons. P. S. ISAEV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 1, 78–82 (1953) *In Russian.*

The equilibrium distribution of shower photons in air is calculated for the energy range 4·3–260 MeV, allowance being made not only for radiation damping and pair production, but also for ionization losses and the Compton effect. The calculation formulae are derived from the results of Tamm and Belen'ki's paper [*J. Phys.* [*USSR*] **1**, 177 (1939)]. The obtained photon spectrum is compared with that calculated by Richards and Nordheim [Abstr. 623 (1949)]; the maximum differences are of the order of 60%. F. LACHMAN

537.591.15

8395. Studies on the stochastic problem of electron-photon cascades. A. RAMAKRISHNAN AND P. M. MATHEWS. *Progr. theor. Phys.*, **11**, 95–117 (*Jan.*, 1954).

A brief review of the well-known fluctuation problem of cosmic radiation is given in a proper historical setting. Numerical calculations for the second moments of the electron distribution are presented as a sequel to those of Bhabha and Chakrabarthy for the mean number. A.

537.591.15

8396. Second and higher maxima in the shower curve of cosmic radiation. J. CLAY. *Proc. K. Ned. Akad. Wetensch. B*, **57**, 29–32 (*Jan.–Feb.*, 1954).

A hodoscoped auto-coincidence counter set has been used to investigate the shower curve for cosmic rays in lead. Evidence is presented for the existence of a second maximum at 17·5 cm thickness of lead. H. ELLIOT

537.591.15

8397. On the production of penetrating showers at different heights and in various materials, especially in hydrogen. H. SCHULTZ. *Z. Naturforsch.*, **9a**, 419–31 (*May*, 1954) *In German.*

The measuring apparatus consisted of an arrangement of lead plates and counters. Only primaries making eight-fold coincidences were measured. Measurements taken at different heights showed an absorption length of 125 ± 5 g/cm² for the primaries, indicating that fast nucleons were responsible for the production. The mean multiplicity of the showers was 5–7. Comparison between paraffin and graphite showed that the same number of showers were produced in corresponding masses. Since the theory of single production in hydrogen, by which these two

substances differ, cannot account for showers of more than three particles, this tends to substantiate the theory of multiple production. The production of showers in graphite, aluminium and iron leads to the same conclusions. G. E. BROWN

537.591.15

8398. Shower structure in the higher shower maxima. W. BOTHE AND H. KRAEMER. Letter in *Phys. Rev.*, **94**, 1402 (*June* 1, 1954).

The second and third maxima in the transition curve in lead have been investigated using an arrangement of counters. The results are interpreted in terms of neutral unstable particles produced in the lead. H. ELLIOT

537.591.2

8399. Energy balance of the cosmic radiation near the equator. V. BENZI. Letter in *Nuovo Cimento*, **11**, 686–7 (*June*, 1954) *In Italian.*

Discusses the energy balance for the vertical flux of cosmic rays at the equator. The discrepancy between the energy flux calculated from the vertical intensity, and that estimated from the primary spectrum of protons and heavier nuclei is decreased if κ-meson production is taken into account. P. ROTHWELL

537.591.5

8400. Cosmic radiation intensity-time variations and their origin. IV. Increases associated with solar flares. J. FIROR. *Phys. Rev.*, **94**, 1017–28 (*May* 15, 1954).

For Pt II, see Abstr. 6925 (1954). The distribution on the earth of the impact points for particles of magnetic rigidities 1 to 10 BV, which originally approach the earth from the direction of the sun, is derived, using principally the published results of numerical integrations of cosmic-ray orbits and model experiments on the motion of charged particles in a dipole magnetic field. Three impact zones for such particles are discussed. Two of these zones include only a small range of local times, and for the special case of the sun in the plane of the geomagnetic equator, are centred near 4 a.m. and 9 a.m. The third zone has no strong local time dependence. Assuming the source of charged particles to subtend a finite angle at the earth, the relative counting rates for detectors in the three zones are estimated. The counting rate due to particles from the sun is expected to be three to seven times larger in the morning zones than in the background, or nonlocal-time-dependent, zone. The morning impact zones are shown to have a seasonal motion of several hours in local time. Reports of observations made during four large increases of cosmic-ray intensity at the times of solar flares are compared with the distribution predicted for particles from the sun. The observed increases agree with the predicted distribution and counting rate except at very high latitudes on the earth. A possible reason for this discrepancy is suggested. Cosmic-ray data from the Climax neutron detectors are analysed for possible increases associated with small solar flares. An increase of $\simeq 1\%$ is found for flares occurring when the detector is in a morning impact zone for particles from the sun. No increase of more than $\simeq 0{\cdot}3\%$ is found for flares occurring when the detector is not in these zones. The mean daily cycle of cosmic-ray intensity is also shown to depend on the rate of flares occurring on the sun. The intensity curve is peaked during the early morning hours for flare periods relative to periods in which few or no flares occurred, in agreement with the supposition that new particles approach the earth from the direction of the sun at the times of flares. A.

537.591.5

8401. Cosmic radiation intensity-time variations and their origin. V. The daily variation of intensity. J. W. FIROR, W. H. FONGER AND J. A. SIMPSON. *Phys. Rev.*, **94**, 1031–6 (*May* 15, 1954).

Properties of the 24-hour intensity variations which were established by ion chamber and counter telescope measurements at high primary-particle energies have now been extended to the low-energy portion of the primary spectrum by measurements with high-altitude neutron piles at geomagnetic latitudes 0° and 48°. The observations demonstrate that the peak-to-peak amplitude of the 24-hour variation increases with latitude and, hence, is dependent on primary-particle rigidity. The latitude ratio for the peak-to-peak variation is $\sim 1{\cdot}4 \pm 0{\cdot}2$ and the amplitude at 48° is of the order 1%. These facts preclude primary neutrons or a general solar dipole field as the origin of this intensity variation. It is shown that although the amplitude of the variation changes from day to day, the amplitudes of the intensity variations of particles at low and at high energy are related. It is further shown that the amplitude on one day persists for only the next 1 or 2 days and that there is not a strong 27-day recurrence tendency. The general features of the changes in peak-to-peak amplitudes of the monthly average 24-hour variations appear in both neutron detectors and in the Freiburg ionization chamber. Arguments based on the experimental observations are presented to exclude meteorological factors, the terrestrial magnetic field variations, and simple geoelectric field accelerations as the origin of the variation. Since it is shown that the particles which produce the 24-hour variation are charged and have their highest intensity near or after noon local time, it does not appear probable that they come from the direction of the sun. Although it is doubtful that this variation is of terrestrial origin, no proof has yet been given that the variation is of extra terrestrial origin. A.

537.591.8

8402. Meson showers and high-energy interactions in light and heavy nuclei. R. W. PARSONS, F. A. BRISBOUT AND V. D. HOPPER. *Phys. Rev.*, **95**, 193–7 (*July* 1, 1954).

A study has been made of nuclear disintegrations produced in electron-sensitive emulsions exposed to cosmic radiation at 80 000 ft. Of 93 stars containing more than three shower particles, 29 were interpreted as being induced in the light nuclei C, N, O, and 64 in the heavy nuclei Ag and Br. The low-energy tracks appear to be emitted isotropically from a slowly moving nucleus and the forward collimation of the remaining tracks is discussed. The average numbers of shower particles from the heavy and light nuclei are $7{\cdot}7$ and $6{\cdot}4_5$ respectively, and it is shown that these figures are consistent with multiple processes of meson production. The difference between the angular distributions of shower particles from heavy and light

nuclei is discussed on the assumption that it is mainly due to scattering. A.

MAGNETISM 538

538.082

8403. The accuracy of determination of the magnetic susceptibility of solids by the Gouy method. C. M. FRENCH AND D. HARRISON. *J. Chem. Soc.*, **1953**, 2538–40 (*Sept.*).

The errors incurred in the determination by various differences in experimental procedure (particularly in methods of packing) and in other factors are examined. A.

538.082

8404. Magnetic susceptibility as measured by Gouy's method with the specimen in a fixed position. O. M. HILAL AND G. E. FREDERICKS. *J. Chem. Soc.*, **1954**, 785–6 (*March*).

A refinement of Gouy's method of measuring magnetic susceptibilities is described, the position of the specimen in the magnetic field being fixed. The value for benzene was determined at 20°, water being the reference standard. The results indicate a reproducibility of better than 0·04% and the value for benzene was $10^6\chi^{20} = -0{\cdot}7012 \pm 0{\cdot}0002$. A.

538.082

8405. The effect of dissolved oxygen on diagmagnetic susceptibilities. B. C. EGGLESTON, D. F. EVANS AND R. E. RICHARDS. *J. Chem. Soc.*, **1954**, 941–3 (*March*).

It is shown that oxygen exerts its normal paramagnetism when dissolved in benzene and in heptane, and the true susceptibilities of these liquids are changed by about 4·5% and 8·5% respectively, when they are saturated with oxygen. This effect has been overlooked by earlier workers, probably because the liquids take up atmospheric oxygen very rapidly. This is demonstrated for the particular case of toluene by spectrophotometric measurements. Diamagnetic susceptibilities of organic liquids saturated with air may therefore be in error by as much as 1·7%. Two types of Gouy tubes are described, which can be evacuated, and are suitable for use with organic liquids. A.

538.082 : 621.317.42

8406. A new magnetometric procedure for the recording of magnetization curves. R. KÜHNE. *Z. angew. Phys.*, **6**, *No.* 3, 131–2 (1954) *In German.*

Describes the use of an even-harmonic-type of fluxgate magnetometer for the presentation on a c.r.o. of magnetization curves and loops for elongated specimens. Static measurements or dynamic loops at frequencies up to 100 c/s can be observed.

A. E. DE BARR

538.082.74

8407. The flux linkage with a search coil produced by a coaxial uniformly magnetized prolate spheroid. G. H. HUNT. *Brit. J. appl. Phys.*, **5**, 260–3 (*July*, 1954).

An expression is derived for the flux enclosed by a search coil coaxial with a uniformly magnetized prolate spheroid. The expression takes the form of power series with coefficients which can readily be calculated from mathematical tables. A.

538.113

8408. Free electron diamagnetism and susceptibilities of the alkali metals. N. H. MARCH AND B. DONOVAN. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 464–5 (*May*, 1954).

Shows that the effect of the correlation energy of free electrons in metals is to reduce the diamagnetic susceptibility at 0°K almost to the Landau value, counteracting the effect of the exchange energy. The experimental values for Na, Li and K are discussed.

E. P. WOHLFARTH

538.114

8409. On the spontaneous magnetizations of honeycomb and kagomé Ising lattices. S. NAYA. *Progr. theor. Phys.*, **11**, 53–62 (*Jan.*, 1954).

The spontaneous magnetizations for the honeycomb and kagomé lattice are obtained by transforming Potts's results for the triangular lattice. Potts's relations are discussed. A.

538.114

8410. A refinement of the Pauling theory of ferromagnetism. G. FELSENFELD. *Proc. Nat. Acad. Sci. U.S.A.*, **40**, 145–9 (*March*, 1954).

See Abstr. 8519 (1953). Describes a method of modifying the theory by taking account of the non-uniform electron density. E. P. WOHLFARTH

538.114

8411. Spin precession in a Bloch wall vibrating with small amplitude. I. LUCAS. *Z. Naturforsch.*, **9a**, 373–6 (*May*, 1954) *In German.*

The characteristic frequency of a vibrating 180° Bloch wall is calculated assuming the binding forces of the wall to be represented by an equivalent internal field $(I/\chi_0)(\delta/l)$, where δ is the wall thickness and l the domain width. The calculated value differs by a factor $\sqrt{2}$ from the value calculated by Döring for a 90° wall, using the effective mass concept.

E. P. WOHLFARTH

538.114

8412. Molecular field treatment of magnetic ordering transitions. E. W. ELCOCK. Letter in *Phys. Rev.*, **94**, 1070–1 (*May* 15, 1954).

Derives an expression for the minimum free energy of atoms distributed on a body centred cubic lattice, the interaction with nearest neighbours being ferromagnetic, with next nearest neighbours antiferromagnetic. The temperature variation of the interaction parameter is taken into account in a simple way. The expression differs from one derived by Smart [Abstr. 8517 (1953)], which is criticized. Application is made to the conditions for ordering transitions in antiferromagnetic substances, e.g. MnAs.

E. P. WOHLFARTH

538.114

8413. The magnetic properties of alloys of cobalt and nickel with palladium and platinum. E. P. WOHLFARTH. Letter in *Phil. Mag.*, **45**, 647–9 (*June*, 1954).

Gives a qualitative interpretation of the variation with atomic concentration of the Curie temperatures of the Pd and Pt rich alloys, on the basis of some of the ideas underlying the collective electron treatment of ferromagnetism [see also Abstr. 5176 (1950); 8523 (1953); 2570 (1954)]. E. P. WOHLFARTH

538.114 : 539.11

8414. Ferromagnetism and band structure of transition metals. F. Bader, K. Ganzhorn and U. Dehlinger. *Z. Phys.*, **137**, *No.* 2, 190–9 (1954) *In German.*

A new band scheme for all transition metals is described, based on the symmetry properties of the wave functions of the *d*-electrons and the effect of the splitting of the bands into partial bands having bonding and anti-bonding properties. The spin distribution is determined by three semi-empirical rules, viz. (1) the electrons in the partial bands responsible for bonding have antiparallel spins on neighbouring atoms, and conversely; (2) the exclusion principle holds for the separate atoms in the crystal; (3) Hund's rule is obeyed as far as possible. Antiferromagnetism is therefore predicted in some cases, particularly for Cr, Mo and W. The Slater curve (magnetization as a function of atomic number) is interpreted for the ferromagnetic metals and alloys. The paramagnetism of γ-Fe is explained. Other physical properties covered by the treatment are lattice stability, electronic heat and the Hall effect. E. P. WOHLFARTH

538.114 : 539.11

8415. Magneton number and energy band occupation of the Heusler alloy Cu_2MnAl. E. Vogt. Note in *Z. Naturforsch.*, **9a**, 473–4 (*May*, 1954) *In German.*

An application of the theoretical scheme proposed by Bader *et al.* (preceding abstract). The distribution of electrons is deduced. E. P. WOHLFARTH

538.22

8416. Crystal structure and magnetic properties. L. Néel. *Bull. Soc. Franç. Minéral Crist.*, **77**, 257–74 (*Jan.–March*, 1954) *In French.*

A review discussing the following topics: magnetic properties of substances, exchange forces, ferrimagnetism, magneto-crystalline forces, superlattice formation by orientation [Abstr. 7548 (1954)], magnetic viscosity, structure sensitive properties of ferromagnetics. 54 references. E. P. WOHLFARTH

538.22

8417. Search for antiferromagnetism in the silicides V_3Si, Cr_3Si and Mo_3Si. W. C. Koehler and E. O. Wollan. Letter in *Phys. Rev.*, **95**, 280–1 (*July* 1, 1954).

Reports results of neutron diffraction experiments. Contrary to Zener's predictions only a very small antiferromagnetic moment (upper limit $0{\cdot}2\ \mu_B$) has been observed, both from the coherent and the diffuse scattering data. E. P. WOHLFARTH

538.22 : 548.7

8418. Crystallography and magnetism. E. F. Bertaut. *Bull. Soc. Franç. Minéral. Crist.*, **77**, 275–92 (*Jan.–March*, 1954) *In French.*

A review discussing the following topics: X-ray crystallography of antiferromagnetics and ferrimagnetics, coercivity, neutron diffraction, order-disorder transformations. 92 references. E. P. WOHLFARTH

538.221

8419. Effect of the dimensions of a core specimen made from Ni–Zn ferrites on its magnetic spectrum. L. A. Fomenko. Letter in *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 365–6 (1953) *In Russian.*

See Abstr. 5898 (1952). It has been found that the order of magnitude of the constants of magnetic viscosity for ferrites in the range $5\times10^4 - 6\times10^7$ c/s is not substantially affected by the size of the core specimen. F. LACHMAN

538.221

8420. The magnetization of very thin iron films. W. Reincke. *Z. Phys.*, **137**, *No.* 2, 169–74 (1954) *In German.*

Describes results of measurements of the magnetization as a function of field strength for iron films deposited on glass plates. Film thicknesses ranged from 10 to 300 Å. The magnetization vanishes for a film of thickness 11 Å; for films <100 Å saturation is reached in much lower fields than for thicker films. Comparison is made with calculations by Klein and Smith [Abstr. 4528 (1951)]. E. P. WOHLFARTH

538.221

8421. New ferromagnetic materials in the group of rare earths; the alloys gadolinium-magnesium. F. Gaume-Mahn. *Bull. Soc. Chim. France*, **21**, 569–75 (*May*, 1954) *In French.*

Describes the preparation and some of the properties of Gd–Mg alloys containing from 0–100% Gd. Up to 10% (atomic) Gd the alloys are paramagnetic, the paramagnetism being attributed to the presence of $GdMg_9$, the presence of which was revealed by X-ray investigation. From 10–25% (atomic) Gd the alloys are paramagnetic and indicate the presence of $GdMg_9$ and $GdMg_3$. From 25–50% Gd the alloys are ferromagnetic at low temperatures with a Curie point of 103°K, suggesting the presence of GdMg, whilst from 50–90% Gd, an additional (ferromagnetic) Curie point of 266°K was also found. Above 90% Gd the Curie point observed was that of Gd, i.e. 289°K. A. E. DE BARR

538.221

8422. Observation of exchange interaction effects in ferromagnetics by spin wave resonance. G. T. Rado and J. R. Weertman. Letter in *Phys. Rev.*, **94**, 1386 (*June* 1, 1954).

Shows how it is possible to measure the "exchange shift" $\Delta H/H$ of the static resonance field. Measurements were made for a 66% Ni–34% Fe alloy which has zero magnetocrystalline anisotropy; ΔH is made large enough to be measurable by producing a small skin depth. The complex permeability was measured at 3 kMc/s in static fields up to 100 oersted. The results are interpreted if the g value is taken to equal 2·42 and the "exchange stiffness constant" $3{\cdot}2\times10^{-6}$ erg cm^{-1}. E. P. WOHLFARTH

538.221

8423. Magnetic anisotropy of NiF_2. L. M. Matarrese and J. W. Stout. Letter in *Phys. Rev.*, **94**, 1792–3 (*June* 15, 1954).

Reports results of torque curve measurements on a single crystal at 20·4°K, i.e. below the transition temperature. The results indicate some ferromagnetic rather than the expected pure antiferromagnetic behaviour; the saturation magnetization deduced from the measurements is 3% of that of the Ni ions. E. P. WOHLFARTH

538.221 : 539.152.2

Radiation damping in magnetic resonance experiments. *See Abstr.* 8532

538.222

8424. Spin coupling in cobalt cyanides with three magnetic ions. J. Wucher, T. Karantassis and N. Perakis. *C.R. Acad. Sci.* [*Paris*] **238,** 1647–9 (*April* 21, 1954) *In French.*

Gives results of susceptibility measurements on the substances $M_3[Co(CN)_6]_2$, M = Ni, Cu, at temperatures between 15° and 288°K. Inverse susceptibility, temperature curves are fitted to the Curie–Weiss law over limited temperature ranges, and the results are discussed in terms of the amount of spin coupling at different temperatures. See also Abstr. 2836, 5896 (1952); 2584 (1954). E. P. WOHLFARTH

538.222

8425. Paramagnetic resonance in activated carbon. D. J. E. Ingram and J. E. Bennett. Letter in *Phil. Mag.*, **45,** 545–7 (*May*, 1954).

A narrow free electron resonance line is found in all samples of activated carbon and is sometimes accompanied by weaker hyperfine structure which is presumed due to paramagnetic ions impurity.

D. H. WHIFFEN

538.222

8426. Electron spin resonance in metals at low fields. H. S. Gutowsky and P. J. Frank. Letter in *Phys. Rev.*, **94,** 1067 (*May* 15, 1954).

Electron resonance was observed at 25 Mc/s for Li and Na metal suspensions with fields 0–25 gauss. The width between points of max. slope was 4·4 gauss, temperature independent for Li and 9·7 gauss at 385°K decreasing to 3·6 gauss at 77°K for Na.

D. H. WHIFFEN

538.222

8427. Paramagnetic resonance spectra of Wurster's free radical ions. S. I. Weissman. Letter in *J. chem. Phys.*, **22,** 1135–6 (*June*, 1954).

Fine structures of up to 40 lines are found in the free radicals obtained from *p*-phenylenediamine and related compounds. D. H. WHIFFEN

538.222

8428. Paramagnetic resonance in phthalocyanine, chlorophyll and haemoglobin derivatives. D. J. E. Ingram and J. E. Bennett. Letter in *J. chem. Phys.*, **22,** 1136–7 (*June*, 1954).

538.222

8429. The anomalous magnetic behavior of UI_3 from 1–4·2°K. L. D. Roberts, D. E. Lavalle and R. A. Erickson. Letter in *J. chem. Phys.*, **22,** 1145–6 (*June*, 1954).

Reports of measurements of the complex susceptibility components at a frequency 500 c/s and in fields up to 1850 oersted. An antiferromagnetic transition point was observed at 3·2°K. Another susceptibility maximum was observed at 1·5°K and its magnitude was found to be field dependent. E. P. WOHLFARTH

538.222

8430. Spin resonance of donors in silicon. R. C. Fletcher, W. A. Yager, G. L. Pearson, A. N. Holden, W. T. Read and F. R. Merritt. Letter in *Phys. Rev.*, **94,** 1392–3 (*June* 1, 1954).

Si crystals with As^{75} donor impurities gave 4 hyperfine peaks 73 Oe apart in paramagnetic resonance at 24 000 Mc/s and 4·2°K. The splitting was shown to be due to As (spin 3/2) since its replacement by P^{31} (spin 1/2) changed the pattern to two hyperfine peaks 42 Oe apart. D. H. WHIFFEN

538.222 : 532.73

8431. Proton relaxation in Mn^{++} aqueous solutions. J. R. Zimmerman. Letter in *J. chem. Phys.*, **22,** 950 (*May*, 1954).

Normally the addition of paramagnetic ions to H_2O solutions affects the proton relaxation times so that $1/T_1 \propto N_{ion}$ and $T_1/T_2 \sim 1$ as found with Cu^{++}, Fe^{++}, Fe^{+++}, Co^{++}, Ni^{++} and V^{++++} ions. For Mn^{++} T_1 is of the expected order but $T_1/T_2 \sim 10$.

D. H. WHIFFEN

538.222 : 534.23

8432. On the possibility of orienting atomic nuclei in metals by paramagnetic absorption of ultrasonics. A. Kastler. Letter in *J. Phys. Radium*, **15,** 300–1 (*April*, 1954) *In French.*

Increase of electron spin temperature for metals entails orientation of the nuclei, so that nuclear resonance signals can be increased with power saturation of the electron resonance [Abstr. 1565 (1954)]. It is here suggested that ultrasonic paramagnetic absorption [Abstr. 3214 (1954)] should have the same effect on the nuclear resonance signal and have the experimental advantage of penetration of the metal.

D. H. WHIFFEN

538.224

8433. Temperature variation of the magnetic susceptibility of several carbon blacks. A. Marchand. *C.R. Acad. Sci.* [*Paris*] **238,** 1645–7 (*April* 21, 1954) *In French.*

See Abstr. 4732 (1954) for earlier work. Describes measurements on samples with graphite crystallite diameters between 40 and 250 Å over a temperature range 70° to 290°K. The numerical value of the susceptibility increases rapidly with increasing diameter; for the smaller crystallites it is practically temperature-independent. E. P. WOHLFARTH

538.224 : 539.133

8434. Nonempirical calculation of the diamagnetic anisotropy of benzene. T. Itoh, K. Ohno and H. Yoshizumi. Letter in *J. chem. Phys.*, **22,** 947–8 (*May*, 1954).

This has been calculated by allowing interaction in the presence of a magnetic field between the nine $^1A_{1g}$ and three $^1A_{2g}$ configurations which arise by raising one or two electrons from the orbitals which they occupy in the lowest configuration. The configurations are constructed of MO's which are LCAO's modified by the magnetic field. The final calculated value is −16·80, the experimental value −33·9. The discrepancy may arise from the LCAO approximation, from the methods used to approximate to the integrals, and from neglect of σ-electrons.

A. J. TAYLOR

538.23

8435. Impurity [magnetic] lag in weak alternating fields. Validity of Rayleigh's law. A. Marais. *C.R. Acad. Sci.* [*Paris*] **238,** 1782–4 (*May* 5, 1954) *In French.*

Using a Maxwell bridge it was possible to separate the time-dependent and time-independent components of the complex permeability of a silicon-iron specimen. The observed results are compared with

curves calculated on the basis of Rayleigh's law, allowing for skin effect. A. E. DE BARR

538.23.08 : 621.317.431

8436. Phase distortion in the B and H circuits for oscilloscopic representation of ferromagnetic hysteresis loops. G. C. VEKHSLER. *Zh. tekh. Fiz.*, **23**, *No.* 5, 806–16 (1953) *In Russian.*

The effect of phase distortion in amplifiers and integrating networks on the form of such B–H loops is investigated. The maximum error in phase angle for negligible change in the form of the displayed B–H loop is discussed. Methods are suggested for compensating the phase distortion in the B and H channels over a given frequency band, and a mathematical treatment of these is given. V. V. ZAKHAROV

538.24

8437. On the possibility of the negative Barkhausen effect. K. WOTRUBA. Letter in *Czech J. Phys.*, **3**, 162–4 (*June*, 1953) *In Russian.*

A previously reported experiment [Abstr. 3642 (1951)] is repeated under carefully described conditions. The effect is not observed. Three reasons are given for the discrepancy. Differentiation may be taking place in the RC-coupled amplifier previously used. This would give the impression of a negative-going impulse. The present amplifier is directly coupled. The sample material was originally coupled into both the compensating and pick-up coils in the apparatus. It now lies under the pick-up coil only. The previous results may refer to magnetic moments much smaller than those encountered here ($4{\cdot}6\times10^{-6}$ c.g.s.). A circuit diagram of the amplifier is given and also a sketch of the test coil. S. C. DUNN

538.244.2 : 612.84: 621.318.3

8438. An ophthalmic magnet. L. R. BLAKE. *J. sci. Instrum.*, **31**, 237–40 (*July*, 1954).

The attractive force of an ophthalmic magnet (used for removing ferromagnetic foreign bodies from the eye) is shown to depend on the input power to the magnet and is independent of the magnet size. For a particular value of attractive force, the size depends on the safe excitation time of the magnet, that is, the time for the winding temperature to reach its safe limiting value. By designing the magnetic circuit to optimize the attractive force, and by matching more closely than is usual in eye magnets the safe excitation time with the time required to perform an eye operation, it proved possible to obtain with a 13 lb 4 kW hand magnet, an attractive force several times greater than most ophthalmic magnets in present use. The magnet is rated conservatively at 19 sec continuous excitation. Since an operation requires only a second or so, there seems no good reason against a further reduction in excitation time to permit a higher attractive force or an even smaller size. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3 : 621.3.011

8439. The Coulomb force and the Ampère force. P. MOON AND D. E. SPENCER. *J. Franklin Inst.*, **257**, 305–15 (*April*, 1954).

A preliminary study of electrodynamics based on an equation for the force between moving but unaccelerated charges. It is proved that the unique equation for force between current elements, consistent with a summation of forces between charges and the Ampère experiments, is Ampère's original equation. The usual "Ampère equation" given in modern textbooks, however, is not the equation used by Ampère and cannot be derived from a force between moving charges. Since the modern treatment of the magnetic field stems from the so-called "Ampère equation," the entire electromagnetic theory obtained by the customary procedure is open to question. A.

538.5

8440. The field H and induction B of a linear current in space. E. DURAND. *C.R. Acad. Sci.* [*Paris*] **238**, 1394–6 (*March* 29, 1954) *In French.*

A fundamental difference is established between the two vectors H and B. The general expressions derived are verified for the particular case of a circular current. G. F. HODSMAN

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56 : 621.3.013

8441. The use of instantaneous point sources or Green's functions in evaluating electromagnetic fields. J. J. SMITH. *Commun. and Electronics*, *No.* 11, 82–8 (*March*, 1954).

A generalization of the methods of a previous paper [Abstr. 4921 (1953)] to cover the case of time-variant fields. Among examples treated are the fields due to straight wires of finite and infinite length and also the fields in waveguides and resonant cavities excited by given currents. G. D. SIMS (R)

538.565 : 621.372.413

8442. On the normal oscillations of an open cavity. M. JESSEL. *C.R. Acad. Sci.* [*Paris*] **238**, 1205–6 (*March* 15, 1954) *In French.*

The proper modes of a closed cavity are not sufficient to specify the fields existing in a cavity with apertures in its walls. It is proposed that the fields can be completely determined by the addition of series of normal modes appropriate to the fields in the apertures. G. D. SIMS

538.565 : 621.372.413 : 621.317.39

8443. A simple bridge method of measurement of the time constant of exponential decays. D. F. GIBBS AND C. M. BURRELL. Note in *Brit. J. appl. Phys.*, **5**, 196 (*May*, 1954).

Referring to an earlier article [Abstr. 2594 (1954)] it is stated that the assumption of current balance in the given conditions is invalid except under new conditions. In reply C. M. Burrell admits the correction as far as it goes but points out that in practice the proposed conditions are actually carried out and that negligible error results. E. H. W. BANNER

538.566

8444. On the group velocity. P. POINCELOT. *C.R. Acad. Sci.* [*Paris*] **238**, 1289–91 (*March* 22, 1954) *In French.*

It is shown that when a signal in the form of a step

function propagates in a dispersive medium whose refractive index n is given by $n = \sqrt{[1 - (a^2/\omega^2)]}$, the steady-state regime is established at infinity immediately. See also Abstr. 3730 (1952). G. D. SIMS

538.566

8445. Comments on J. H. Crysdale's "Letter to the Editor." G. BEKEFI. *J. appl. Phys.*, **25**, 808–9 (*June*, 1954). See Abstr. 5815 (1954).

538.566

8446. Reaction concept in electromagnetic theory. V. H. RUMSEY. *Phys. Rev.*, **94**, 1483–91 (*June* 15, 1954).

A physical observable called the reaction is defined to simplify the formulation of boundary value problems in electromagnetic theory. To illustrate its value it is used to obtain formulae for scattering coefficients, transmission coefficients and aperture impedances. An approximate solution to problems of this type is obtained by replacing the correct source (of the scattered field for example) with an approximate source which is adjusted so that its reaction with certain "test" sources is correct. This insures that the approximate source "looks" the same as the correct source according to the physical tests which are inherent in the problem. The formulae so obtained have a stationary character (for the cases considered) and thus the results could also be obtained from a variational approach. However, the physical approach has two important advantages. It is general whereas the variational technique has to be worked out for each problem. It is conceptually simple and leads directly to results which might not be uncovered by the variational approach because of the complexity of the mathematical formulation. The problem of scattering by a dielectric body is used to illustrate this latter point. A.

538.566 : 532.5

8447. Dimensional relations in magnetohydrodynamics. W. M. ELSASSER. *Phys. Rev.*, **95**, 1–5 (*July* 1, 1954).

An analysis of the dimensional relations characteristic of electromagnetic phenomena in fluids of large dimensions is carried out. Most dimensionless quantities are found to be exceedingly small, or large, compared to unity, with resultant simplifications of the theory. It is found that, in the absence of instabilities, the conditions for the acceleration of particles to the higher cosmic-ray energies are favourable only when the linear dimensions of the fluids involved are very large. A.

538.566 : 621.372.8

8448. The excitation of plane surface waves. A. L. CULLEN. *Proc. Instn Elect. Engrs IV*, **101**, 225–34 (*Aug.*, 1954).

For abstract, see Abstr. 3686 (1954).

538.566 : 621.396.11

8449. The reflection of electromagnetic waves from a rough surface. H. DAVIES. *Proc. Instn Elect. Engrs IV*, **101**, 209–14 (*Aug.*, 1954).

For abstract, see Abstr. 2608 (1954).

538.566

8450. Diffraction of electromagnetic waves, produced by an arbitrarily orientated electric or magnetic dipole, at a perfectly conducting half-plane. YU. V. VANDAKUROV. *Zh. éksper. teor. Fiz.*, **26**, *No.* 1, 3–18 (1954) *In Russian.*

A mathematical generalization of the problem first treated by Sommerfeld and an expression is obtained for the incident and diffracted field in terms of integrals of known functions. J. M. HOUGH

538.566 : 621.317.382.029.64

8451. Measurement of power by a thermoacoustic method at centimetric wave lengths. G. A. VASIL'EV AND M. E. ZHABOTINSKIĬ. *Zh. éksper. teor. Fiz.*, **24**, *No.* 5, 571–4 (1953) *In Russian.*

This is measured by producing pressure variations of the gas enclosed in a waveguide, corresponding to modulation of the waves, using a thermoacoustic detector. The pressure variations so produced are detected by means of a microphone with associated electronic apparatus to enhance its sensitivity. A block diagram of the experimental set-up is given. V. V. ZAKHAROV

538.566 : 621.372.8

8452. Experiments on the Faraday rotation of guided waves. A. A. T. M. VAN TRIER. Letter in *Appl. sci. Res. B*, **3**, *No.* 2, 142–4 (1953).

Direct determination of polarization of waves in a circular waveguide containing a ferrite element is approximate because of (*a*) reflections from various transitions in measuring apparatus, (*b*) difficulty in observing small rotations and small losses. These difficulties are overcome using the following technique: A ferrite rod is mounted coaxially in a cylindrical cavity which is tuned by a moving plunger fitting around the ferrite. Resonances occur at distances of $\lambda g/2$ when the ferrite is not magnetized. An axial magnetic field causes splitting of these resonances for the right and left circularly polarized component waves. Then, from the knowledge of $\lambda g_{+,-}/2$ the different propagation constants β_+ and β_- can be determined. Z. F. WOJNAR (R)

538.566 : 621.372.8

8453. Propagation in an artificial dielectric. R. FORTET. *Ann. Télécomm.*, **8**, 361–6 (*Nov.*, 1953) *In French.*

A mathematical paper. The structure consists of homogeneous dielectric slices (or "free zones") alternating with slices where the dielectric is subdivided by metal sheets into a succession of "limited zones." The conditions under which the Maxwell equations for each zone are separately satisfied are considered. Matching at the boundary between the two zones leads to an infinite system of linear homogeneous equations. After a general discussion the simple case treated by Brillouin [*Wave propagation in periodic structures* (1946)] is considered. This is illustrated by 2 numerical examples in which the degree of approximation is discussed. In conclusion the analysis is extended to the general case. J. M. C. DUKES

538.566 : 621.372.8

8454. The pass-band and dispersion of waveguides loaded by circular irises. R. COMBE. *C.R. Acad. Sci. [Paris]* **238**, 1697–9 (*April* 26, 1954) *In French.*

A statement of the dispersion relation and its dependence on mechanical tolerances. Experimental results taken at 10 cm support the validity of the formulae. G. D. SIMS

538.566.2

8455. On the radiation of long waves of a horizontal dipole in the air cavity between earth and ionosphere. I. V. O. SCHUMANN. *Z. angew. Phys.*, **6**, *No.* 5, 225–9 (1954) *In German.*

The wavelength is considered so long that the ionosphere may be treated as a conductor with known resistance. The mathematical solution of this problem, treating the earth as having finite conductivity, is derived with the aid of the Hertzian potential.

J. M. HOUGH

538.566.2 : 523.3

8456. Lunar radio echoes and the Faraday effect in the ionosphere. W. A. S. MURRAY AND J. K. HARGREAVES. Letter in *Nature* [*London*] **173**, 944–5 (*May* 15, 1954).

Lunar echoes were observed during thirty periods close to lunar transit, on 120 Mc/s with a plane-polarized aerial of aperture 250 m², 50 000 echoes being analysed. Except on two nights of ionospheric disturbance, long-period fading (up to 1 hr) was observed only in daytime runs, particularly within a few hours of sunrise. It is suggested that this fading is due to rotation of the plane of polarization of the radio waves traversing the ionosphere in the presence of the earth's magnetic field. The change of mean electron density required by this interpretation is consistent with the rate of change of electron density in the *F*-region associated with the night–day transition. The interpretation receives some support from observations of echoes transmitted by a horizontally-polarized aerial, and received with an aerial which can be rapidly switched between vertical and horizontal polarizations.

M. W. OVENDEN

538.566.3

8457. On the influence of the earth's magnetic field on the interaction of radiowaves in the ionosphere. L. M. VILENSKIĬ. *Zh. éksper. teor. Fiz.*, **26**, *No.* 1, 42–56 (1954) *In Russian.*

Extension of previous work [Abstr. 983 (1953)] to show that the effect of the earth's field gives a large amplitude to the cross-modulation not only when the original frequencies, f_1 and f_2, are such that $f_1 \sim 2f_2$ but also if $f_1 + 2f_2 \sim f_H, f_1 \sim 2f_2 + f_H$ or $f_1 + f_H \sim 2f_2$ where f_H is the gyromagnetic frequency of an electron in the earth's field.

J. M. HOUGH

538.566.3 : 621.396.11

8458. Ray-path characteristics in the ionosphere. G. MILLINGTON. *Proc. Instn Elect. Engrs IV*, **101**, 235–49 (*Aug.*, 1954).

For abstract, see Abstr. 6747 (1954).

MAGNETIC EFFECTS 538.6

538.613 : 778.37

On the application of the Faraday effect to the development of a high-speed repetitive recording technique and to flash-tube photography. *See Abstr.* 7984

538.632 : 537.311.33

Method of measuring the Hall effect in semiconductors. *See Abstr.* 8275

538.639 : 537.312.5

Photoconductivity and photoelectromagnetic effects in InSb. *See Abstr.* 8304

538.653

8459. Irreversible change of the remanent magnetization of plastically deformed nickel. L. REIMER. *Z. Phys.*, **137**, *No.* 5, 588–94 (1954) *In German.*

Interprets measurements due to Förster and Stambke [*Z. Metallkunde.*, **33**, 97 (1941)] and Dehlinger and Scholl [*Z. Metallkunde.*, **44**, 136 (1953)]. The observed remanence increase is believed to be due to residual lattice strains; an approximate relation $\Delta I_R/I_R = 0{\cdot}05$ is derived. Investigations were also carried out on the thermal recovery and the reversible decrease of ΔI_R due to a decrease in temperature.

E. P. WOHLFARTH

538.66

8460. Thermomagnetic properties of thin metallic films. F. J. BLATT. *Phys. Rev.*, **95**, 13–15 (*July* 1, 1954).

The calculation of Sondheimer on the galvanomagnetic effects in thin metallic films is extended so as to permit the evaluation of the Nernst, Ettinghausen, and Leduc–Righi coefficients (A_N, A_E, A_L). It is assumed that the conduction electrons are quasi-free and that a relaxation time exists. General expressions are derived for A_N, A_E and A_L and the asymptotic forms are given in the limit of the ratio of film thickness to mean free path much less than unity. As this ratio approaches zero, A_N and A_L vanish whereas A_E becomes infinite.

A.

538.67 : 537.523

8461. The generation of magnetic fields in rotating liquid mercury. F. BURHORN, H. GRIEM AND W. LOCHTE-HOLTGREVEN. *Z. Phys.*, **137**, *No.* 2, 175–89 (1954) *In German.*

See Abstr. 8429 (1953), 2623 (1954) for a brief account of the essentials of this work which is here described in greater experimental and theoretical detail.

E. P. WOHLFARTH

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

8462. A method for a rigorous treatment of the interaction of an electron and several lattice oscillators. H. HAKEN. *Z. Phys.*, **138**, *No.* 1, 56–70 (1954) *In German.*

Derives a relation between energy and a pseudo wave vector on the basis of earlier work [Abstr. 6763 (1954)] on the structure of the solution of the wave equation in a very general case. Some information is also derived about the solutions themselves. See also Abstr. 8607 (1953).

E. P. WOHLFARTH

539.11

8463. The application of the phenomenological theory of irreversible processes to continuous systems in an inhomogeneous magnetic field. K.-J. HANSZEN. *Z. Naturforsch.*, **9a**, 323–31 (*April*, 1954) *In German.*

The sedimentation of mixed phases with electrically

neutral or charged components is investigated, treating the magnetic variables as internal parameters. The electrical potential differences due to the sedimentation of the ions are calculated. F. ANSBACHER

539.11

8464. On the field-theoretical description of solid bodies. H. KÜMMEL. *Z. Naturforsch.*, **9a**, 331–5 (*April*, 1954) *In German.*

The Feynman–Dyson method of graphs is applied to the field theory of solids. The method becomes simple if the electrons are treated as free according to the Bloch approximation without phonon interaction. The appropriate Bethe–Salpeter equation (B.S.E.) for the interaction of 2 electrons is investigated. From the existence of "attraction" in momentum space no conclusions about bound states can be drawn, because the homogeneous B.S.E. has no solution. F. ANSBACHER

539.11

8465. Volume changes in a substitutional alloy. D. TER HAAR AND A. W. ROSS. Note in *Proc. Phys. Soc.* [*London*] **67**, 388–91 (*April*, 1954).

The changes in volume that would be expected to accompany order-disorder transitions in a substitutional alloy are investigated by considering a linear chain consisting of atoms of two kinds. The value of dL/dT (L being the length of the chain and T the temperature) is calculated as a function of T for two models. The behaviour of dL/dT follows that of the specific heat C_p very closely. In a two- or three-dimensional alloy the coefficient of expansion would be expected to show a discontinuity at the Curie point. M. R. HOPKINS

539.11

8466. The lattice energies of copper subgroup and thallous halides. A. P. ALTSHULLER. Letter in *J. chem. Phys.*, **22**, 1136 (*June*, 1954).

The lattice energies of the halides of Cu, Ag, Au, and Tl are re-calculated using recent more accurate data for the heats of sublimation of the metals. The values for Cu and Ag halides are appreciably higher than those given by theory which signifies that there are appreciable homopolar contributions to the lattice energies. W. GOOD

539.11

8467. Localized perturbations. M. LAX. Letter in *Phys. Rev.*, **94**, 1391–2 (*June* 1, 1954).

A general matrix method is presented for treating problems involving strong localized perturbations in an otherwise soluble problem, such as the vibrations of a lattice in the neighbourhood of an impurity centre. A. D. LE CLAIRE

539.11

8468. Simplified LCAO method for the periodic potential problem. J. C. SLATER AND G. F. KOSTER. *Phys. Rev.*, **94**, 1498–524 (*June* 15, 1954).

The LCAO, or Bloch, or tight binding, approximation for solids is discussed as an interpolation method, to be used in connection with more accurate calculations made by the cellular or orthogonalized plane-wave methods. It is proposed that the various integrals be obtained as disposable constants, so that the tight binding method will agree with accurate calculations at symmetry points in the Brillouin zone for which these calculations have been made, and that the LCAO method then be used for making calculations throughout the Brillouin zone. A general discussion of the method is given, including tables of matrix components of energy for simple cubic, face-centred and body-centred cubic, and diamond structures. Applications are given to the results of Fletcher and Wohlfarth on Ni, and Howarth on Cu, as illustrations of the fcc case. In discussing the bcc case, the splitting of the energy bands in chromium by an antiferromagnetic alternating potential is worked out, as well as a distribution of energy states for the case of no antiferromagnetism. For diamond, comparisons are made with the calculations of Herman, using the orthogonalized plane-wave method. The case of such crystals as InSb is discussed, and it is shown that their properties fit in with the energy band picture. A.

539.11

8469. Stored energy measurements in irradiated copper. A. W. OVERHAUSER. *Phys. Rev.*, **94**, 1551–7 (*June* 15, 1954).

Thin copper foils, cooled to liquid nitrogen temperature, were subjected to bombardment by 12 MeV deuterons. The stored energy released due to annealing of the radiation damage was measured as the foils warmed to room temperature. Below −40°c the stored energy released per °c was approximately uniform and is presumed to result from annihilation of closely spaced interstitial-vacancy pairs produced by the bombardment. A prominent maximum in the annealing spectrum occurred at −15°c and is interpreted as binary recombination of interstitial atoms and vacancies by means of interstitial diffusion. Changes in residual electrical resistivity were also measured. The stored energy to resistivity ratio was found to be $1{\cdot}7 \pm 0{\cdot}2$ cal/gram per micro-ohm-cm, both for the low-temperature processes and the −15°c annealing peak. If the energy of formation of an interstitial-vacancy pair is 5 eV, a value of 11 micro-ohm-cm for the resistivity of one atomic percent of pairs is obtained. The atomic concentration of interstitial atoms and vacancies produced by an irradiation of 10^{17} deuterons/cm^2 at liquid nitrogen temperature is, accordingly, 5×10^{-5}. A.

539.11 : 536.7

8470. Order–disorder phenomena. B. LINDER. *J. chem. Phys.*, **22**, 970–3 (*June*, 1954).

The thermodynamics of the order–disorder transition in β-brass is explored by making the assumption that the energy difference between the disordered and ordered state has the form $E_0 - BT^2$. Such a law suggests itself if the coupling of the thermal expansion to the order–disorder transformation is emphasized and the effect of short-range order is neglected. The constant B is shown to be related to the lattice vibrations of both the ordered and disordered phases. A very rough estimate of B was obtained from electrical resistivity measurements, the assumption being made that the connection between the resistivity and the vibrational frequency, $\rho \propto T/M\theta^2$, holds. A heat capacity *v.* temperature curve, which was calculated on the basis of a non-constant energy of disordering and which also includes the effect of lattice vibrations, is shown to agree well with the experimental one. The usefulness of the form $E_0 - BT^2$ is not confined to β-

brass and the same expression may be applied to systems other than solid–solid. A.

539.11 : 539.31

8471. The atomic theory of elasticity avoiding [the assumption of] central forces. J. LAVAL. *C.R. Acad. Sci.* [*Paris*] **238,** 1773–5 (*May* 3, 1954) *In French.*

The theory for a crystalline medium leads to the same results as the classical theory of the elasticity of a homogeneous medium if it is assumed in the former that the forces between atoms are central. A brief account is given of some of the consequences of avoiding this latter assumption. For example the number of elastic constants required to describe the homogeneous deformation of a triclinic crystal is 45 and of a cubic crystal 4, in place of the 21 and 3 constants respectively required by classical theory. Also, the propagation of elastic waves is described by a set of coefficients distinct from those which describe a static deformation whereas the classical theory employs in the two cases the same set of coefficients.

A. D. LE CLAIRE

539.11 : 548.7

8472. Bound states in dislocations. R. LANDAUER. Letter in *Phys. Rev.*, **94,** 1386–8 (*June* 1, 1954).

Estimation of the trapping energy associated with elastic distortions. A bound state is localized within 10^{-5} cm of the dislocation axis for the case of germanium. C. A. HOGARTH

539.11 : 548.7

8473. A note on the band structure of silicon. D. G. BELL, R. HENSMAN, D. P. JENKINS AND L. PINCHERLE. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67,** 562–3 (*June*, 1954).

The cellular method has been applied to the evaluation of the electronic energy levels of the silicon crystal. Matching of the wave-functions at the boundaries of the cells has been carried out by means of a variational procedure [Abstr. 1512 (1954)]. Results are given for the centre of the Brillouin zone showing that the lowest unoccupied level is triply degenerate. It appears, however, that the bottom of the conduction band is not at $k = 0$. L. PINCHERLE

539.11 : 548.7

8474. The electronic structure of the borides MB_6. H. C. LONGUET-HIGGINS AND M. DE V. ROBERTS. *Proc. Roy. Soc. A*, **224,** 336–47 (*July* 7, 1954).

The electronic structure of the metallic borides MB_6 is investigated theoretically by the tight-binding approximation. The stability of the crystal lattice is interpreted and it is predicted that if M is a bivalent metal the crystal should be an insulator or photoconductor, but that if M has a valency greater than 2 the crystal should exhibit metallic conductivity. These predictions are consistent with the scanty experimental evidence. A.

MOLECULAR STRUCTURE 539.13

539.13

8475. The law of intermolecular interaction at large distances. I. I. ABRIKOSOVA AND B. V. DERYAGIN. *Dokl. Akad. Nauk SSSR*, **90,** *No.* 6, 1055–8 (1953) *In Russian.*

A method has been designed for measuring intermolecular forces at large distances by determining the equivalent molecular attraction between the plane surface of a plate attached on one arm of the balance beam and the convex surface of a lens placed very close above the plate. The very high sensitivity required was attained by attaching to the balance beam (35 mm long and 0·1 g in weight) a frame with 20 wire turns, arranged below a permanent magnet. A current from a photoelectric-cell system, tracking the movement of the beam, was passed through the wire of the frame. The negative feedback regulating system contained: a light source, lenses, a prism, 2 (printing-press type) screens, a mirror attached to the balance beam, and a Cs vacuum photocell connected with the grid of a multiplier valve; the anode current was passed through the wire of the frame. To conduct a measurement, the convex lens was brought so close to the plate as to produce a measurable attraction force. The beam turned then by a very small angle, and the moment involved was balanced by the moment of the negative feedback, calculated from the formula $F = ni/r$, where n is the number of turns in the frame; i, the current in the frame, and r, the length of the force arm. The sensitivity attained was 10^{-7} g, and the oscillation period was reduced to $\sim 10^{-3}$ sec. Results of experiments agree with the quantum-relativist theory of molecular forces and show that London's theory cannot be applied to distances $> 10^{-5}$ cm.

F. LACHMAN

539.13

8476. Transfer of internal energy in molecular collisions of flexible hydrocarbons. W. D. MCGRATH AND A. R. UBBELOHDE. Letter in *Nature* [*London*] **173,** 990 (*May* 22, 1954).

The number of collisions of a pentane or hexane molecule with an ethylene molecule necessary to bring about the transfer of a quantum of vibrational energy 0–1 to the ethylene increases in the order *n-*, *iso-*, *neo-*, *cyclo-* for pentane and *n-*, *iso-*, *cyclo-* for hexane. This dependence on molecular flexibility is in accordance with previous ideas about wrestling collisions, and also makes it understandable that flexibility may affect relative reactivity. A. J. TAYLOR

539.13 : 533.72

8477. Collision diameters of flexible hydrocarbon molecules in the vapour phase: the "hydrogen effect." G. A. MCD. CUMMINGS AND A. R. UBBELOHDE. *J. Chem. Soc.*, **1953,** 3751–5 (*Dec.*).

Mass-diffusion measurements have been carried out by the Stefan method, with hydrogen, nitrogen, oxygen, and argon as carrier gases, at temperatures convenient for the following hydrocarbons: *n*-hexane, 2 : 3-dimethylbutane, *cyclo*hexane, methyl*cyclo*pentane, *n*-octane, 2 : 2 : 4-trimethylpentane, *n*-decane, 2 : 3 : 3-trimethylheptane, and *n*-dodecane. Effective collision diameters have been determined on the basis of simple kinetic-theory formulae for mass diffusion. Such diameters confirm previous conclusions from viscosity data that on an average the flexible molecules are substantially crumpled at ordinary temperatures. Furthermore, in collisions with molecular hydrogen effective collision diameters of flexible hydrocarbons

are larger than for collisions with gases such as nitrogen, oxygen, and argon. This behaviour may be related to other "hydrogen effects" due to facilitating internal-energy ⇌ translational-energy transfers. A.

539.13 : 541.127

8478. Reaction velocity and molecular collisions. Activated complex. M. MAGAT. *Cahiers de Phys., No.* 48, 1–24 (*March*); Erratum *No.* 50, 7 (*July*, 1954) *In French.*

An exposition of the methods of calculating reaction velocities through the quantum theory of molecular collisions. Descriptions are given of the calculation of decomposition rates and other properties of the activated complex, of partition functions, and of the constant of Arrhenius. 28 refs. A. J. TAYLOR

539.13 : 541.127

8479. Calculation and estimation of the height of potential barriers. R. DAUDEL AND O. CHALVET. *Cahiers de Phys., No.* 48, 25–41 (*March*, 1954) *In French.*

A more detailed account of the quantum mechanical methods of calculating the properties of the activated complex (see preceding abstract). Accounts are given of the Born–Oppenheimer approximation, and of the spin-states and LCAO methods of calculating energy levels of complex systems. 23 refs. A. J. TAYLOR

539.13 : 541.127

8480. Molecular structure and chemical reactivity of conjugated organic hydrocarbons. B. PULLMAN. *Cahiers de Phys., No.* 48, 42–66 (*March*, 1954) *In French.*

See also two preceding abstracts. After a description of some valence-band concepts relating to these molecules, the method of molecular orbitals is developed, mobile band-orders, free valence and mutual polarizabilities being introduced. Reactivity is discussed mainly in terms of the last two concepts. 19 refs. A. J. TAYLOR

539.132

8481. Semiempirical potential energy functions. I. The H_2 and H_2^+ diatomic molecules. A. A. FROST AND B. MUSULIN. *J. chem. Phys.*, **22**, 1017–20 (*June*, 1954).

After setting up certain theoretical criteria for a semi-empirical potential energy function, two such functions for H_2^+ and H_2 are constructed, the simplest of which has the form $V = e^{-aR}[(e^2/R) - b]$, where V is the potential energy with its zero corresponding to infinite separation. R is the internuclear distance, e the electronic charge, and a and b parameters. This function is used to correlate the experimental quantities: dissociation energy, equilibrium internuclear distance, force constant, third and fourth derivatives of V with respect to R, united atom energy, and critical distance. A more complicated function is also presented which with one molecular parameter fixed by the dissociation energy is capable of then predicting internuclear distance and force constant. A.

539.132 : 536.66

8482. Heats of dissociation of the XX-type diatomic molecules. S. S. MITRA. *Z. Phys.*, **137**, *No.* 4, 520–2 (1954) *In German.*

Formula $V/D^a = K$ (where V is the ionization potential of the atom X, D the energy of dissociation of the molecule XX, while a and K are constants) is found empirically for the energy of dissociation of the diatomic molecules of the XX type. For the relationship between log V and log D straight lines are obtained for each of the groups of the periodic system. F. LACHMAN

539.132 : 536.7

8483. Substituted methanes. XX. Potential constants and calculated thermodynamic properties for some dibromomethanes. J. M. DOWLING AND A. G. MEISTER. *J. chem. Phys.*, **22**, 1042–4 (*June*, 1954).

For Pt XIX, see Abstr. 1168 (1954). Using previous infrared and Raman data, a reasonable set of potential constants were obtained for CH_2Br_2 and CD_2Br_2, by means of the Wilson FG matrix method, with a potential energy function containing all possible second degree terms. Fundamental frequencies for $CHDBr_2$ were then calculated using the potential constants found for CH_2Br_2 and CD_2Br_2. Finally the heat content, free energy, entropy, and heat capacity for the ideal gaseous state at 1 atmos pressure were calculated for these three molecules for twelve temperatures from 100°K to 1000°K with a rigid rotator harmonic oscillator approximation. A.

539.132 : 537.525 : 535.33.03

Dissociative recombination at surfaces. *See Abstr.* 8133

539.132

8484. Note on the energy-levels of triatomic molecules. S. D. MAJUMDAR. *Curr. Sci.*, **22**, 368–9 (*Dec.*, 1953).

The wave equation for the unsymmetrical top, and the rotational part of that for triatomic molecules, are reducible to an ordinary differential equation which can be solved by the WKB method. Energy corrections due to centrifugal stretching and rotation-vibration interactions are calculated by a perturbation method. Asymptotic expansions, valid for $J > 9$, are obtained for the energy eigenvalues of the top and for the corrections to the energy levels of triatomic molecules. A. J. TAYLOR

539.132

8485. Improved quantum-mechanical calculation of energy and normal vibrations of many-atom molecules. K. ARTMANN. *Z. Phys.*, **137**, *No.* 2, 137–68 (1954) *In German.*

The eigenfunctions of the central atom are considered non-orthogonal, and the non-localized valences of the molecule are taken into account. This produces a number of desirable improvements: the energy is hardly affected but only $\partial^2 E/\partial\theta^2$, which is nearly constant for the 3 molecules discussed, H_2O, H_2S, H_2Se; the absolute value of the Coulomb energy is reduced. J. JACOBS

539.132

8486. The molecular structure of tetracyclone. R. N. JONES, C. SANDORFY AND D. E. TRUCKER. *J. Phys. Radium*, **15**, 320 (*April*, 1954) *In French.*

It has been observed that the CO valence vibration frequency is remarkably constant for various derivatives of tetracyclone (1712 ± 3 cm^{-1}; ε_{max} 450–700 in CS_2 solution). The band is not influenced by substitutions in the para positions of the α-phenyl

groups, but is slightly changed by such substitutions in the β-phenyls, whence it is concluded that slight conjugation exists only between the cyclopentadienone nucleus and the β-phenyls. A. J. TAYLOR

539.132

8487. Molecular dipole rotation and association. M. DAVIES. Note in *Z. Naturforsch.*, **9a**, 474 (*May*, 1954).

With reference to work by Fischer and Fessler [Abstr. 4786–7 (1953)] it is pointed out that infrared spectral observations indicate that aniline associates in CCl_4, and that dimerization accounts for experiments of the author on the distribution of aniline between water and CCl_4. When dimerization is allowed for, a relation used by Fischer in similar simple cases may explain the observed decrease in τ (effective) with increasing concentration without a special mechanism being invoked. A. J. TAYLOR

539.132

8488. Variations of hydrogen rotational magnetic moments with rotational quantum number and with isotopic mass. R. G. BARNES, P. J. BRAY AND N. F. RAMSEY. *Phys. Rev.*, **94**, 893–902 (*May* 15, 1954).

Molecular beam observations have been made of the radiofrequency resonance spectra corresponding to reorientations of the rotational magnetic moment in hydrogen and deuterium molecules. For deuterium in the state $I = J = 1$, these observations were made in magnetic fields of approximately 1800, 3500 and 5100 gauss. The direct result of these experiments is that the rotational magnetic moment of the deuterium molecule in the zeroth vibrational and first rotational states is ${}_0{}^{D}\langle\mu_R\rangle_1 = 0{\cdot}442884 \pm 0{\cdot}000052$ nuclear magneton, and the dependence of diamagnetic susceptibility on molecular orientation is $(\xi_{\pm 1} - \xi_0) = -(3{\cdot}50 \pm 0{\cdot}40)\times 10^{-31}$ erg gauss^{-2} molecule^{-1}. Combining these values with the recent theory of Ramsey on zero-point vibration and centrifugal stretching in molecules leads to an improved evaluation of the molecular susceptibility and quadrupole moment of the electron distribution. The experiments also provide a check on the values of the spin-rotational and spin-spin interaction parameters previously obtained from observations of the resonance spectrum corresponding to reorientations of the total nuclear spin. The observations for hydrogen in the state $I = 0, J = 2$ were made in magnetic fields of approximately 1800 gauss. The direct result of these experiments is that the rotational magnetic moment of the hydrogen molecule in the zeroth vibrational and second rotational states is ${}_0{}^{H}\langle\mu_R/J\rangle_2 = 0{\cdot}882265 \pm 0{\cdot}000035$ nuclear magneton. This value in combination with the known value of $0{\cdot}88291 \pm 0{\cdot}00007$ nuclear magnetons for the first rotational state provides an independent check on the theory of zero-point vibration and centrifugal stretching in molecules and leads to an improved evaluation of the hydrogen molecular susceptibility. A.

539.132

8489. The bipyramidal XY_3Z_2 molecular model. I. Classical vibration problem. J. S. ZIOMEK. *J. chem. Phys.*, **22**, 1001–9 (*June*, 1954).

Symmetry co-ordinates are set up from the standpoint of group theory for describing the normal modes of oscillation of the XY_3Z_2 molecular model in such a manner that maximum factorization of the secular determinant is accomplished. The cubic and quartic portions of the anharmonic potential function are derived, and the components of vibrational angular momentum are set down. The complete valence-type potential function is discussed. Explicit relations are derived between the force constants occurring in the secular determinant and the physical valence force constants. A.

539.132 : 535.343.4–14

Microwave spectrum and barrier to internal rotation of nitromethane. *See Abstr.* 8169

539.132 : 535.375.5 : 535.343–15

The interpretation of the infrared and Raman spectra of the *n* paraffins. *See Abstr.* 8150

539.132 : 548.7

8490. Equivalence of Chang's and Nakamura's theories of hindered rotation in molecular crystals. H. M. JAMES AND T. J. KRIEGER. Letter in *J. chem. Phys.*, **22**, 959–60 (*May*, 1954).

Chang and Nakamura [Abstr. 7455 (1952)] have given theories of "rotational" transitions in crystals which when applied to a certain crystal model lead to different values of ΔC_v at the transition point. By finding the relation between Nakamura's distribution function $g_a(\omega_i)$ and Chang's weight function $g(\omega_i)$ it is shown here that the two theories are equivalent; new calculation has shown that the discrepancy in ΔC_v is due to a numerical error of Chang's. A. J. TAYLOR

539.132 : 535.343

8491. Interaction between electrons in one-dimensional free-electron model with application to absorption spectra of cyanine dyes. G. ARAKI AND H. ARAKI. *Progr. theor. Phys.*, **11**, 20–4 (*Jan.*, 1954).

The interaction between electrons in a deep square-well potential field is discussed in the case of one dimension. The potential of one-dimensional two-electron forces is assumed to be represented by a transversal average of the three-dimensional Coulomb potential. The calculated excitation energy is compared with observed data of absorption maxima for cyanine dyes. A.

539.132

8492. Two-centre interaction integrals. IV. Standard integrals for hetero-nuclear molecules. H. PREUSS. *Z. Naturforsch.*, **9a**, 376–89 (*May*, 1954) *In German.*

Continuation of the series of papers by Kopineck [*Abstr.* 3485 (1953)]. Some of the standard integrals are tabulated which are necessary for the calculation of exchange integrals for the case of unequal nuclear charges. G. FIELD

539.132

8493. Macroscopic equations of quadrupole resonance. F. LURÇAT. *C.R. Acad. Sci.* [*Paris*] **238**, 1386–8 (*March* 29, 1954) *In French.*

Theoretical expressions are obtained for the time rate of change of macroscopic magnetic vector and the "density of quadrupole moment" tensor for a system of identical nuclei each in identical field gradients and radio-frequency field. D. H. WHIFFEN

539.132

8494. New effects in nuclear quadrupole resonance. J. DUCHESNE AND A. MONFILS. *C.R. Acad. Sci.* [*Paris*] **238**, 1801–3 (*May* 3, 1954) *In French.*

A super-reactive oscillator with sinusoidal frequency modulation is used to obtain the derivative of the Cl^{35} quadrupole resonance at 34·282 Mc/s in *p*-dichlorbenzene with a signal/noise ratio of 60. The presence of *p*-dibrombenzene impurity weakens the signal considerably with slight broadening from 1·2 to 3·6 kc/s in the range up to 2% molecular impurity at which the signal is too weak to observe. The rate of transformation from a high temp. crystal modification is shown to be about 5 mm/min from the growth of absorption at 34·282 Mc/s and the decrease at 34·255 Mc/s. D. H. WHIFFEN

539.132

8495. The quadrupole broadening of nuclear magnetic resonance lines in liquids. Y. AYANT. *C.R. Acad. Sci.* [*Paris*] **238**, 1876–8 (*May* 10, 1954) *In French.*

Theoretical expressions are obtained for the width of the Lorentz curve of nuclear magnetic resonance in terms of the spin, the quadrupole moment and the field gradient. D. H. WHIFFEN

539.132

8496. Nuclear quadrupole resonances in solid aryl bromides and iodides. R. G. BARNES, O. B. MILLER AND F. O. WOOTEN. Letter in *J. chem. Phys.*, **22**, 946–7 (*May*, 1954).

539.132

8497. Bromine nuclear quadrupole resonances. P. J. BRAY. Letter in *J. chem. Phys.*, **22**, 950–1 (*May*, 1954).

Resonances are reported for a series of aryl bromides near 230 Mc/s. The signal/noise ratio of a self-quenched super-regenerative spectrometer is better than with external quenching. D. H. WHIFFEN

539.132

8498. "Slow beats" in nuclear quadrupole induction. M. BLOOM. Letter in *Phys. Rev.*, **94**, 1396–7 (*June* 1, 1954).

A static field of 15·5 gauss present when the nuclear quadrupole resonance of Cl^{35} in $NaClO_3$ is observed, causes a mixing of the $+m$ and $-m$ states and causes "slow beats" or a periodic modulation of the echo envelope. Observation and theory agree on the variation of the beat frequency and amplitude as a function of the field orientations relative to the crystal axes. D. H. WHIFFEN

539.132

8499. On the definition of bond order in quantum chemistry. W. BINGEL. *Z. Naturforsch.*, **9a**, 436–9 (*May*, 1954) *In German.*

A comparison of the Pauling Brockway Beach definition with that of Penney. If, in the former, proper account is taken of the overlap integral between two valence structures, the two definitions become identical. J. JACOBS

539.132

8500. Modification of the naive MO method. L. GOODMAN AND H. SHULL. Letter in *J. chem. Phys.*, **22**, 1138 (*June*, 1954).

To include effects of electron repulsion and singlet-triplet splitting, without the core-potential problem and *S–T* splitting over-estimation of the purely theoretical ASMO method, the empirical approach of the naive LCAO MO method is used in the ASMO framework, in discussing conjugated systems. The solutions of the MO secular equation, $\varepsilon_j = \alpha + \eta_j\beta$, are taken as orbital energies, and an empirical β found from one singlet or triplet band, using $^{1,3}\Delta E_{a,b} = \beta(\eta_b - \eta_a) - (J_{ab} - K_{ab}) \pm K_{ab}$, computing the integrals J and K from the naive MO wave functions. This β can then be used to discuss other transitions. The method is suitable for computation of shifts due to substitution. J. HAWGOOD

539.132 : 537.561

The ionization potentials and electronic structures of methyl and ethyl fluoride. *See Abstr.* 8381

539.132

8501. Polarizability and molecular planarity. A. ROUSSET AND A. PACAULT. *C.R. Acad. Sci.* [*Paris*] **238**, 1705–7 (*April* 26, 1954) *In French.*

A new method is proposed for determining the angles between the various benzene rings of polycyclic aromatic molecules, based on the Rayleigh effect (diffusion of light), the magnitude of which is simply related to the three components of the optical polarizability. In the gaseous phase this is obtained from the depolarization, in the liquid or solution from the measurement of Rayleigh's constant. If the ratio of two parameters derived from these measurements is $\leqslant 1$, then in cases of favourable symmetry the interplanar angle can be derived; in the contrary case the molecule is planar. The examples of dibenzyl and di- and tri-phenylmethane are discussed. The effects follow from conjugation of the rings in planar molecules by the π-electrons. A. J. TAYLOR

539.133

8502. Structures of the boron hydrides. W. N. LIPSCOMB. *J. chem. Phys.*, **22**, 985–8 (*June*, 1954).

Evidence for the structures of B_2H_6, B_4H_{10}, B_5H_9, B_5H_{11} and $B_{10}H_{14}$ is reviewed. Correlations of the boron arrangements with known structures have been pointed out, and a systematic discussion of the boron–hydrogen distances is given. A.

539.133

8503. The valence structure of the boron hydrides. W. H. EBERHARDT, B. CRAWFORD, JR AND W. N. LIPSCOMB. *J. chem. Phys.*, **22**, 989–1001 (*June*, 1954).

A set of extended valence postulates is presented including the concept of the localized three-centre bond. These postulates are applied systematically to the boron hydrides and account for their unusual geometry, their unexpected dipole moments, and the fact that they are not "electron-deficient." A.

539.133

8504. Symbolic structural formulas for boron hydrides. J. R. PLATT. *J. chem. Phys.*, **22**, 1033–6 (*June*, 1954).

A structural convention is proposed, intended to serve the same function for boron hydrides that the standard valence bond convention serves for organic compounds. It involves the auxiliary concept of the "valence cone," which is the cone swept out by three tetrahedral orbitals rotating about the fourth as an axis. The known open boron hydrides B_nH_{n+p} then

appear to be even-electron molecules with the boron atoms approximately in a close-packed equilateral-triangular network on the convex surface formed by their overlapping valence cones; with n single B–H bonds normal to this surface; and with p (even) added peripheral hydrogen in the surface located so that every boron atom has neighbours in all three sectors of its valence cone. As long as this network does not form a complete polyhedron, it may be represented on paper by a flat triangular network having the same topology. This prescription gives uniquely and correctly the structures and formulas for the known B_2, B_4, B_5, B_6 and B_{10} hydrides and predicts other possible open compounds up to B_{11}. It would be consistent with the existence of closed inert polyhedral hydrides B_nH_n up to $B_{12}H_{12}$ and with chains and lattices of such polyhedra. A.

539.133

8505. The molecular structure of 1,1,2,2-tetrafluorodichlorethane. M. Iwasaki, S. Nagase and R. Kojima. Letter in *J. chem. Phys.*, **22**, 959 (*May*, 1954).

The molecular structure of CF_2Cl–CF_2Cl has been investigated by electron diffraction. The radial distribution shows that the C–C bond must be shortened to 1·45 Å, as has already been found in other fluorinated hydrocarbons. Rotational isomers *trans* and *gauche* (the existence of which has been shown by Raman and infrared spectra) are found to be present in nearly equimolecular numbers. A. J. TAYLOR

539.133

8506. On the rotary mobility of the methoxy group. G. Klages. *Z. Naturforsch.*, **9a**, 358–61 (*April*, 1954) *In German.*

The rotation diffusion constant of the OCH_3 group under rotation about the CO bond depends on the size of the molecule, as had been deduced from measurements of the dielectric relaxation time. This dependence is discussed on the basis of a model in which the group is rigidly attached to the benzene ring in certain positions. For 2 groups in meta position on one ring a self-mobility of $0{\cdot}5\times10^{11}$ sec^{-1} for the non-rigidly attached positions must be assumed. J. JACOBS

539.133

8507. The C–C valence spectrum of substituted and isomeric hydrocarbons. L. Kellner. *J. Phys. Radium*, **15**, 309–13 (*April*, 1954) *In French.*

Calculations of the skeleton stretching frequencies are made for straight-chain olefines, cyclic olefines and singly methylated aliphatic chains and compared with the known Raman shifts. D. H. WHIFFEN

539.133

8508. A spectroscopic study of the nature of complexes of purines with aromatic compounds. J. Booth, E. Boyland and S. F. D. Orr. *J. Phys. Radium*, **15**, 315–17 (*April*, 1954) *In French.*

Slight changes in infrared spectra are observed as a result of the formation of crystalline complexes of caffeine and tetramethyluric acid with polycyclic hydrocarbons, dibenzcarbazoles, and other polycyclic aromatic compounds; similar changes are observed in concentrated chloroform solution. The theory is put forward that the formation of these complexes is due not only to a lower crystalline energy than that of the constituents, but also to a small attractive force arising from the polarization of the polycyclic aromatic by the polar molecule. The modified electronic distributions can explain the observed spectral changes, the C=O bonds in the purine losing double-bond character and the C–N bonds gaining it. A. J. TAYLOR

539.133

8509. The effects of hydrogen bonding on the deformation frequencies of the hydroxyl group in alcohols. A. V. Stuart and G. B. B. M. Sutherland. *J. Phys. Radium*, **15**, 321–3 (*April*, 1954) *In French.*

These have been studied in the vibration spectra of a series of alcohols, as pure liquids, as dilute solutions in inert solvents, and as vapours, and of some deuterated alcohols. "Association" bands near 1410, 1110 and 670 cm^{-1} are weakened by dilution, i.e. reduction of hydrogen bonding; a "monomeric" band near 1225 is present only on dilution. The 670 band in methanol is shifted to $670/\sqrt{2} = 475$ by deuteration; it is attributed to a separable deformation of OH, the H atom moving out of the COH plane. The 1410 and 1225 bands are attributed to the in-plane deformation in associated and monomeric alcohols, respectively. They are neither present, nor shifted by $\sqrt{2}$, in OD spectra; this vibration is thus not independent of others. Some methanol vibrations are exceptional for the primary series, but similar to tertiary ones; e.g. the 1410 band is single for methanol and tertiaries, but double for primaries and secondaries, suggesting that the 3-fold symmetry is involved, and confirming the non-separability. J. HAWGOOD

539.133 : 535.343

Molecular structure of phenolphthalein, fluorescein and derivatives. *See Abstr.* 8146

539.133 : 535.343–15

The infrared spectrum and the configuration of the molecule of formamide. *See Abstr.* 8151

539.133

8510. Statistical computation of mean dimensions of macromolecules. I. F. T. Wall, L. A. Hiller, Jr and D. J. Wheeler. *J. chem. Phys.*, **22**, 1036–41 (*June*, 1954).

The configurations of flexible coiling type polymer molecules have been investigated statistically with a high-speed electronic digital computer by generation of large numbers of "random walks." These walks were carried out subject to the excluded volume effect in simple cubic and tetrahedral lattices. It was found that the walk attrition obeys an exponential decay law with a half-walk of 6·7 steps in the cubic lattice and 17·3 steps for the tetrahedral. Mean square end-to-end separations, $\langle r_n^2\rangle_{Av}$, were also obtained, and two distinct kinds of empirical formulae have been fitted to the data. So far, the statistical data are insufficient to establish unequivocally the nature of the functional dependence of $\langle r_n^2\rangle_{Av}$ for large values of n, the number of steps. A study was also made on the probabilities of ring closures for restricted random walks in the cubic system. It was found that for rings greater than 6 steps, the probability of formation varies inversely as the square of the ring size. A.

539.133 : 538.224

Nonempirical calculation of the diamagnetic anisotropy of benzene. *See Abstr.* 8434

ATOMIC STRUCTURE . NUCLEUS
ISOTOPES 539.15

539.152.1

8511. Statistical theory of the atomic nucleus. B. KERIMOV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 299–302 (1953) *In Russian.*

Develops the idea of D. Ivanenko and A. Sokolov [*Classical field theory*, GITTL, Moscow–Leningrad (1951) *pp.* 402–4], according to which, in statistical theories of heavy nuclei, the assumption of mesons having a smaller mass than that usually accepted can yield values of bonding energy and nuclear radius in relatively better agreement with experimental data. The stability of heavy nuclei is investigated from the point of view of the field theory of nuclear forces. The bonding energy is expressed as a function of the mass number A and of the nuclear bonding parameters. The range of variation is found for the meson mass and the bonding parameters, within which the nuclear equilibrium is possible.

F. LACHMAN

539.152.1

8512. Non-linear meson equations and saturation of nuclear forces. P. MITTELSTAEDT. *Z. Phys.*, **137**, *No.* 5, 545–71 (1954) *In German.*

The nuclear potential is taken to satisfy the equation of Schiff and Thirring $\Delta\phi(r) - \mu^2\phi(r) - \lambda g^4\phi^3(r) = -g\rho(r)$ where $\rho(r)$ is the classical nucleon density, g and λ are constants which are determined from the experimental binding energy. The binding energy can then be given as a function of Z, the atomic number, and it is found that this agrees reasonably with the Weizsäcker–Bethe formula. The density of nucleons and width of the surface layer are in agreement with previous results.

G. E. BROWN

539.152.1

8513. Analogous states in heavy isobaric nuclei. V. S. SHPINEL'. *Zh. éksper. teor. Fiz.*, **24**, *No.* 1, 90–2 (1953) *In Russian.*

Levels are compared in pairs of odd-number isobaric nuclei, the Z values of which differ by 2 units. It is possible to deduce from the available literature the occurrence of states which can be looked upon as analogous. The excitation energies for analogous states are almost identical if the number of the neutrons is odd, whereas for the case of odd-number proton the excitation energy is less for the isobar with a greater Z value. It is suggested that this behaviour is due to the Coulombic interaction of the odd-number nucleon.

F. LACHMAN

539.152.1

8514. Similar states of isobaric nuclei. B. S. DZHELEPOV. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 4, 391–410 (1953) *In Russian.*

A detailed discussion (starting with a review of mirror nuclei) of the information on nuclear levels obtained from β, γ decays and (d,p), (d,n) or (n,α), (p,α) reactions, with the object of bringing out the correspondence between the ground states or a ground and an excited state of pairs of isobars connected by the interchange of a proton and neutron ("similar states"). It is concluded that for such states the isotopic spin, as well as the spin and parity, are the same. Certain modifications of selection rules result, e.g. forbidden transitions of the type $+0 \rightarrow +0$ may become favoured allowed ($C^{10} \rightarrow 1{\cdot}74$ MeV B^{10} and $O^{14} \rightarrow 2{\cdot}31$ MeV N^{14}). The rôle of the isotopic spin in the reactions B^{10} $(d,d')B^{10}$, $B^{10}(\alpha,\alpha')$ B^{10} is discussed. 100 references.

W. J. SWIATECKI

539.152.1

8515. Binding energy of nuclei and the single particle model. K. WOESTE. *Z. Phys.*, **137**, *No.* 2, 228–37 (1954) *In German.*

Nuclear binding energies are explained quantitatively on the single-particle model by making proper allowance for the dependence of nuclear potential on atomic number. Nuclei can only exist in the immediate neighbourhood of the Gamow valley, since, outside this region, the number of nucleons is larger than the number of available levels in the one-particle potential corresponding to this nucleon number.

P. T. MATTHEWS

539.152.1

8516. Phase transitions in atomic nuclei. V. F. WEISSKOPF. *Proc. Amer. Acad. Arts Sci.*, **82**, *No.* 7, 360–4 (1954).

Qualitative aspects of nuclear energy level density are discussed. The well-ordered states of independent particle motion are viewed as one "phase" of nuclear matter, which can be changed into the phase of high level density and aggregate motion by supplying energy through a bombarding particle; this process might be considered analogous to melting. Present experiments employing incident neutrons of $\simeq 14$ MeV raise the "nuclear temperature" of all heavy nuclei ($A > 40$) by about the same amount. This may mean that only part of the nucleus is melted.

G. E. BROWN

539.152.1

8517. Nuclear potential well depth. R. K. ADAIR. Letter in *Phys. Rev.*, **94**, 737–8 (*May* 1, 1954).

Analysis of slow neutron scattering lengths suggests that the well depths used in optical-model calculations at low energy ["cloudy crystal ball" calculations, Abstr. 5081 (1953)] should be increased from 19 to 40 MeV.

J. M. CASSELS

539.152.1

8518. The symmetry relations of the 12j symbol. R. J. ORD-SMITH. *Phys. Rev.*, **94**, 1227–8 (*June* 1, 1954).

A triangular-condition diagram in the form of a Möbius strip is constructed for the 12j symbol, and those geometrical transformations of the strip which preserve the conditions are considered. This suggests a revised notation for the 12j symbol which exhibits clearly the triangular conditions. The transformations of the strip suggest a complete set of sixteen symmetry relations, which can be verified by use of an explicit expression for the symbol. In the new notation the symmetry relations are obtained easily as simple manipulative rules. The positions of the elements in the symbol also display the difference

between the two sets of elements of the symbol with respect to degeneration by setting one element zero. See also Abstr. 4828 (1954). A.

539.152.1

8519. A modified shell model of odd-even nuclei. A. B. VOLKOV. *Phys. Rev.*, **94**, 1664–70 (*June* 15, 1954).

Certain magnetic interaction data (static magnetic moments and "forbidden" magnetic dipole transitions) are interpreted on the basis of a modified shell model of odd-even nuclei. The nuclear wave-function is assumed to be primarily an equally weighted admixture of states formed from all possible odd-particle configurations within the odd-particle open shell of the Mayer–Jensen shell model. These configurations are coupled in a prescribed manner so as to give the total angular momentum and parity of the nucleus. The agreement with the data represents a considerable improvement over the Mayer–Jensen model. A.

539.152.1

8520. On two systems of nuclear excited states. L. K. PEKER AND L. A. SLIV. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 4, 411–27 (1953) *In Russian.*

The excited states up to 1·5 MeV of odd A nuclei with $20 \leqslant Z \leqslant 80$ are analysed in terms of 2 types of single particle excitations: (*a*) lifting of the odd nucleon to a higher level available on the shell model ("consecutive" levels), (*b*) lifting of a nucleon from a filled shell with the resulting formation of a hole ("hole" levels). The spectra of the following nuclei exhibit these features and are discussed in detail: Co^{59}, Cd^{111}, $Cs^{131, 133}$ (consecutive); Cu^{65}, Zn^{67}, Ge^{73}, Xe^{131}, Pf^{195}, Hg^{199}, Pb^{207} (hole). The spectra of Pb^{85}, Sr^{87}, $Y^{89,91}$, Mo^{95}, In^{115}, Ni^{61}, Pd^{105}, Lu^{175}, Rh^{103}, $Pm^{147, 149}$ exhibit both types of excitation. In these cases there is a notable absence of γ-transitions between the 2 families of levels, which suggest an additional selection rule on transitions involving the re-arrangement of more than 1 particle.

W. J. SWIATECKI

539.152.1

8521. On the lower energy levels of Li^6. T. ISHIDZU AND S. OBI. Letter in *Progr. theor. Phys.*, **10**, 690–2 (*Dec.*, 1953).

Calculation of these levels is carried out employing a tensor force, a spin exchange and central force. Fair agreement with experiment is obtained.

G. E. BROWN

539.152.1

8522. Low-lying states of Be^8. E. W. TITTERTON. Letter in *Phys. Rev.*, **94**, 206–7 (*April* 1, 1954).

Recent work at Canberra suggests even states of Be^8 at 4·05, 5·3 and 7·5 MeV, and provides evidence against a state at 4·9 MeV de-exciting by γ-ray emission. A. O. STANESBY

539.152.1

8523. Rotational nuclear energy levels from Coulomb excitation. G. M. TEMMER AND N. P. HEYDENBURG. Letter in *Phys. Rev.*, **94**, 1399–400 (*June* 1, 1954).

Coulomb excitation of excited states in 11 elements in the region of the rare earth group have been obtained using 3·4 MeV α-particles. The relative positions of the first two excited states, deduced from the γ-ray energies and attributed to rotational nuclear states of the odd A isotopes, agree closely with the predictions of the collective model of the nucleus [see Abstr. 7638 (1954)]. M. A. GRACE

539.152.1

8524. Nuclear energy levels of Tl^{203}. J. VARMA. *Phys. Rev.*, **94**, 1688–94 (*June* 15, 1954).

Using scintillation spectrometry and coincidence counting techniques, Tl^{203}, formed by orbital electron capture in Pb^{203}, has been shown to emit γ-rays of energies 280, 403 and 683 keV. The 403 and 280 keV γ-rays were found to be in sequence; the 683 keV ray represents the associated cross-over transition. By energy and conversion coefficient measurements, it has been shown that the same 280 ± 2 keV level of Tl^{203} is excited in the decay of both Hg^{203} and Pb^{203}. A coincidence method for the measurement of the conversion coefficients of the 403 keV γ-rays is described. The K-shell conversion coefficient of the 403 keV γ-ray has been measured as 0·076, the $K/(L + M)$ ratio being 3·7. The angular correlation function for the 403 keV–280 keV cascade has the form $W(\theta) = 1 - (0{\cdot}152 \pm 0{\cdot}007)\cos^2\theta$. For the known multipole mixture of the 280 keV quantum, the correlation measurements indicate the 403 keV transition to be 76% $E2$ and 24% $M1$. The interference phases of the $E2$ and $M1$ matrices of both transitions are the same in Lloyd's notation. The angular correlation studies and the conversion coefficient measurements indicate the orbitals of the levels of Tl^{203} to be $d_{5/2}$, $d_{3/2}$ and $s_{1/2}$, in order of decreasing excitation energy. The spin of the ground state of Pb^{203} is shown to be 5/2(−). A.

539.152.1

8525. Ground state of Al^{26}. J. C. KLUYVER, C. VAN DER LEUN AND P. M. ENDT. Letter in *Phys. Rev.*, **94**, 1795 (*June* 15, 1954).

The reaction $Mg^{25}(p,\gamma)Al^{26}$ has been used to investigate the lowest states of Al^{26}. The experimental evidence is compatible with the assumption that the ground state has total isotopic spin $T = 0$ and the level at 0·46 MeV, $T = 1$. P. T. MATTHEWS

539.152.1 : 539.172.13

8526. Low excited states of F^{19}. I. Proton inelastic scattering. R. W. PETERSON, C. A. BARNES, W. A. FOWLER AND C. C. LAURITSEN. Letter in *Phys. Rev.*, **94**, 1075 (*May* 15, 1954).

Magnetically analysed inelastic proton groups at 159°, from 1·431 MeV bombardment of F^{19}, show excited states at $113{\cdot}9 \pm 0{\cdot}8$ and $199{\cdot}6 \pm 0{\cdot}7$ keV. Excitation curves and angular distributions of the 114 and 200 keV γ's are consistent with spin assignments $\frac{1}{2}-$ and $\frac{5}{2}+$ respectively. Spin and parity assignments of 6 levels in Ne^{20} from angular distribution of elastic p's. See abstracts following.

W. J. SWIATECKI

539.152.1 : 539.163.1

8527. Low excited states of F^{19}. II. Lifetime measurements. J. THIRION, C. A. BARNES AND C. C. LAURITSEN. Letter in *Phys. Rev.*, **94**, 1076 (*May* 15, 1954).

Using the recoil technique [Abstr. 1611 (1954)] the lifetimes of the 114 and 200 keV lines were found to be $(1{\cdot}0 \pm 0{\cdot}25) \times 10^{-9}$ and $0{\cdot}8 \times 10^{-7}$ sec. Compare abstract following. W. J. SWIATECKI

539.152.1 : 539.172.11

8528. Low excited states of F^{19}. III. Coulomb excitation by α particles. R. SHERR, C. W. LI AND R. F. CHRISTY. Letter in *Phys. Rev.*, **94**, 1076–7 (*May* 15, 1954).

Excitation curves for the 114 and 200 keV levels and angular distributions of the resulting γ's agree with the theory of Coulomb excitation if spin assignments $\frac{1}{2}^-$ and $\frac{5}{2}^+$ are made. The $\frac{1}{2}^-$ is in contradiction with the usual interpretation of the shell model. W. J. SWIATECKI

539.152.1 : 539.166

8529. Low excited states of F^{19}. IV. Angular distributions. R. F. CHRISTY. Letter in *Phys. Rev.*, **94**, 1077–8 (*May* 15, 1954).

The angular distributions of inelastic protons and subsequent γ's, studied in preceding abstracts, are consistent with assignments $\frac{1}{2}^-$ (isotropic) and $\frac{5}{2}^+$ ($1 + B_p \cos^2\theta$ for protons, $1 + B_\gamma \cos^2\theta$ for γ's). Theoretically there is a relation between B_p and B_γ; comparison with experiment suggests some precession of the spin in the case of the $\frac{5}{2}^+$, 10^{-7} sec state. W. J. SWIATECKI

539.152.2

8530. Alignment and polarization of atomic nuclei. G.-J. BÉNÉ. *Arch. Sci.* [*Geneva*] **7**, *No.* 1, 15–25 (1954) *In French.*

A review of the methods of attaining nuclear spin alignment and of its measurement. D. H. WHIFFEN

539.152.2

8531. Orientation of nuclei by saturation of paramagnetic resonance. J. KORRINGA. Letter in *Phys. Rev.*, **94**, 1388 (*June* 1, 1954).

Explanation of the mechanism by which saturation of the paramagnetic electron resonance in crystals can lead to orientation of the nuclear spins. D. H. WHIFFEN

539.152.2 : 535.338.33

The arc spectrum of iodine and the quadrupole moment of I^{127}. *See Abstr.* 8135

539.152.2 : 538.221

8532. Radiation damping in magnetic resonance experiments. N. BLOEMBERGEN AND R. V. POUND. *Phys. Rev.*, **95**, 8–12 (*July* 1, 1954).

Magnetic resonance experiments can be described by analogy to a coupled pair of circuits, one of which is the ordinary electrical resonant circuit. The other circuit is formed by the rotating magnetization. For transient phenomena, such as occur, e.g. in the pulse techniques of free nuclear induction, the coupling gives rise to a damping of the magnetic resonance by the electric circuit. Such damping can also be considered as spontaneous radiation damping. It is shown that in certain cases of nuclear induction this radiation damping is more important than the damping from the spin-spin and the spin-lattice relaxation mechanisms usually considered. For ferromagnetic materials at microwave frequencies the radiation damping can become very large. A.

539.153

8533. Analytical wave functions and energy values of the lithium-type atoms. M. G. VESELOV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 1, 65–8 (1953) *In Russian.*

Wave-functions have been derived and energy values calculated for atoms with 3 electrons and any value of Z (nuclear charge) by the method of variation of parameters in the analytical expressions for the H-type atom. Semi-empirical formulae have been constructed for: (1) the total energy $W = -1{\cdot}125Z^2 + 1{\cdot}0028Z - 0{\cdot}3962 - 0{\cdot}0727/Z - 1{\cdot}078 \times 10^{-5}Z^4$; (2) the ionization potential $I = 0{\cdot}125Z^2 - 0{\cdot}3978Z + 0{\cdot}2437 + 0{\cdot}0674/Z + 1{\cdot}46 \times 10^{-6}Z^4$ of the Li-type atoms. Owing to the introduction of the semi-empirical Z^4 terms allowing for the relativistic effects, these formulae agree with experimental data within the limits of accuracy of spectroscopical measurements. F. LACHMAN

539.153

8534. The triplet splitting of terms of the carbon atom in configuration $1s^2 2s^2 2p3p$. V. K. SHUGUROV, YA. I. VIZBARAÏTE AND A. P. YUTSIS. *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 265–8 (1953) *In Russian.*

Expressions are given for the elements of the energy matrix of spin interaction, using the radial integral for an atom in the $1s^2 2s^2 2p3p$ configuration. The triplet splitting of C atoms in this configuration is determined, allowance being made for the non-diagonal matrix elements, with the use of one-electron wave-functions of a self-consistent field without quantum exchange. See Abstr. 7203 (1949), 5661 (1953). F. LACHMAN

539.153

8535. On the formulation of rules for the filling of electron levels. V. M. KLECHKOVSKIĬ. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 5, 923–6 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-220.*

A further discussion of the rule previously suggested by the author [Abstr. 3526 (1953)], according to which the filling of quantum levels proceeds according to increasing values of $n + l$, and, within a group of constant $n + l$, according to increasing values of n. Predictions of this rule are, in particular, compared with results of the application of Fermi statistics with exchange correction. L. PINCHERLE

539.153

8536. Relation between the average volume occupied by an electron in the electron cloud [cortège] of an atom and the average electric potential existing in that domain. S. ODIOT AND R. DAUDEL. *C.R. Acad. Sci.* [*Paris*] **238**, 1384–6 (*March* 29, 1954) *In French.*

It is found that the average volume occupied by an electron in the domain which can be associated with a shell of the atom is approximately inversely proportional to the 3/2 power of the average potential within that domain. J. HUGHES

539.153

8537. Gyromagnetic ratio in the hyperfine structure of doublet states. W. W. CLENDENIN. *Phys. Rev.*, **94**, 1590–2 (*June* 15, 1954).

Perturbation of the hyperfine structure of an electronic $p_{1/2}$ state by the $p_{3/2}$ state is calculated using relativistic electronic functions. The main effects are a change in apparent nuclear g factor and a common lowering of all $p_{1/2}$ sublevels. Energy corrections due to the perturbation of one level of a doublet term by the other when i is $\frac{1}{2}$ and j is arbitrary are also obtained. A.

539.153 : 537.12/.13

8538. Formation of metastable compounds from elementary particles (positronium). A. A. SOKOLOV AND V. N. TSYTOVICH. *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 253–64 (1953) *In Russian.*

See Abstr. 1005–7, 4971 (1949); 1504, 3320 (1950); 5380 (1951); 267, 2917 (1952). Discusses the interaction between quantized states, and the wave-functions with fourth-order matrices are converted into those with second-order matrices. Approximate formulae are obtained for the interaction between 2 charged particles and, finally, the wave-functions and energy of positronium are derived, thus enabling the possibility of formation of metastable positronium states to be assessed. The positronium transitions in magnetic fields are discussed.

F. LACHMAN

539.153 : 539.152.2

8539. Hyperfine structure and nuclear moments of the stable bromine isotopes. J. G. KING AND V. JACCARINO. *Phys. Rev.*, **94**, 1610–16 (*June* 15, 1954).

The hyperfine structure of the $^2P_{\frac{3}{2}}$ state of atomic Br^{79} and Br^{81} has been investigated by the atomic-beam, magnetic-resonance method. The following values have been obtained for the nuclear magnetic dipole interaction constant, a, and the nuclear electric quadrupole interaction constant, b: $a^{79} = 884{\cdot}810 \pm 0{\cdot}003$ Mc/s, $a^{81} = 953{\cdot}770 \pm 0{\cdot}003$ Mc/s, $b^{79} = -384{\cdot}878 \pm 0{\cdot}008$ Mc/s, $b^{81} = -321{\cdot}516 \pm 0{\cdot}008$ Mc/s. From these data, an upper limit of 0·0001 Mc/s can be placed on the nuclear magnetic octupole interaction constant, c. Applying the results of recent theoretical calculations by Sternheimer and Koster, the following values of the nuclear quadrupole moments were computed: $Q^{79} = (0{\cdot}33 \pm 0{\cdot}02) \times 10^{-24}$ cm², $Q^{81} = (0{\cdot}28 \pm 0{\cdot}02) \times 10^{-24}$ cm². The ratios (a^{79}/a^{81}) and (b^{79}/b^{81}) are in satisfactory agreement with the ratios (μ^{79}/μ^{81}) and (eqQ^{79}/eqQ^{81}), respectively, as measured by other methods. An experimental technique is given for combining many of the advantages of the "flop-out" resonance method with those of the "flop-in" resonance method in the analysis of complex spectra. Increased importance can be assigned to the hyperfine structure interaction constants of pairs of isotopes in view of the available information on the ground states of nuclei and on nuclear structure, and the fact that new methods exist for precise measurements of the ratio of nuclear moments. A.

539.153 : 539.152.2

8540. Hyperfine structure of I^{127}. Nuclear magnetic octupole moment. V. JACCARINO, J. G. KING, R. A. SATTEN AND H. H. STROKE. Letter in *Phys. Rev.*, **94**, 1798 (*June* 15, 1954).

Atomic beam magnetic resonance has been used to obtain the hyperfine structure of the $^2P_{3/2}$ ground state of I^{127} and shows a magnetic octupole coupling constant of $0{\cdot}00245 \pm 0{\cdot}00037$ Mc/s and an octupole moment of $+0{\cdot}3\,\mu_n \times 10^{-24}$ cm², which is in agreement with a $d_{5/2}$ proton in a single-particle orbit. Correction has to be made for perturbation by the adjacent $^2P_{1/2}$ level. D. H. WHIFFEN

539.153 : 539.152.2

8541. Hyperfine structure of In^{115}. Evidence of a nuclear octupole moment. P. KUSCH AND T. G. ECK. Letter in *Phys. Rev.*, **94**, 1799 (*June* 15, 1954).

After correction for $^2P_{3/2} - {}^2P_{1/2}$ perturbations, the atomic beam magnetic resonance hyperfine structure of the $^2P_{3/2}$ state of In^{115} is shown to require a magnetic octupole coupling constant of $0{\cdot}000497 \pm 0{\cdot}000033$ Mc/s. D. H. WHIFFEN

539.153.1 : 541.57

8542. Atomic radii. IV. Dependence of interatomic distance on bond energy. M. L. HUGGINS. *J. Amer. Chem. Soc.*, **75**, 4126–33 (*Sept.* 5, 1953).

It is shown that most of the departures from strict additivity of radii in normal valence compounds can be attributed to variations in bond energy, D_{AB}. A set of "constant energy radii," r_A^*, has been computed. The simple relationship, $r_{AB} = r_A^* + r_B - \frac{1}{2} \log D_{AB}$, yields interatomic distances which average within 0·02 Å of the best experimental values. If experimental bond energies are not available, values computed from electronegativities and non-polar bond-energy contributions [see Abstr. 8744 (1954)] can be used, with but little loss of accuracy. A.

539.153.4

8543. Studies of atomic self-consistent fields. II. Interpolation problems. P.-O. LÖWDIN. *Phys. Rev.*, **94**, 1600–9 (*June* 15, 1954).

For Pt I, see Abstr. 4296 (1953). By studying the self-consistent-field (SCF) functions tabulated in the literature, it is shown that a quantity, which for a hydrogen-like function would equal the atomic number Z, for SCF functions will represent a form of "effective nuclear charge" Z_{eff}, which for a series of consecutive atoms or ions appears to be an almost linear function of the atomic number, convenient for interpolation purposes. The positions and magnitudes of maxima and minima, nodes, derivatives in origin, eigenvalues, etc., are investigated by considering the corresponding effective nuclear charges. It is important that the nodes may be interpolated separately, since the logarithm of an SCF function, divided by a polynomial having the same zero points as the function itself, may be used for interpolating SCF functions as a whole. This logarithm may also be used for defining a continuously varying effective charge $Z_{\text{eff}}(r)$, which is convenient for interpolation purposes or for estimating fields with exchange from those without exchange. A.

539.153.4

8544. Relativistic Thomas–Fermi atom model. J. J. GILVARRY. *Phys. Rev.*, **95**, 71–2 (*July* 1, 1954).

It is shown that an expression for the density of states derived from the Dirac wave equation for a central field removes the convergence difficulties in the usual relativistic Thomas–Fermi equation. A.

539.153.4

8545. Approximate Hartree-type wave functions and matrix elements for the K and L shells of atoms and ions. R. E. MEYEROTT. *Phys. Rev.*, **95**, 72–82 (*July* 1, 1954).

Perturbation effects of electron screening on wave-functions and dipole matrix elements of K and L electrons of ions or inner shells of atoms have been computed to order Z^{-1}. Some screening effects of this order have also been computed for the M shell.

Some of the terms of order Z^{-2} have also been evaluated and found to be small compared with those neglected in this paper. The dipole matrix elements have been used to compute X-ray mass absorption coefficients and the comparison with the experimental values is discussed. A.

539.154.2

8546. The length of the periods in the Periodic System. F. TÜDÓS. Note in *Naturwissenschaften*, **41**, *No.* 6, 138 (1954).

It is suggested that the number of electrons in the n-th shell can be represented by the formula: $L_n = 2[(n/2) + 1]^2$, where $[(n/2) + 1]$ is the largest integer in $(n/2) + 1$. J. HUGHES

539.155.2 : 532.14

Density of heavy water and electrolytic enrichment of the oxygen isotope. *See Abstr.* 8083

539.155.2 : 539.232 : 541.183.5

Fractionation of oxygen isotopes during the formation of metal oxide films. *See Abstr.* 8743

539.155.4

8547. A new mass spectrographic determination of the masses of H^1, D^2, He^4, C^{12} and N^{14}. J. MATTAUCH AND R. BIERI. *Z. Naturforsch.*, **9a**, 303–23 (*April*, 1954) *In German.*

The masses were measured by the doublet method with an error of 0·3 to 0·6 parts/million. The methods of making the measurements, of evaluating the results and the sources and magnitudes of the errors are discussed. The following values for the mass differences (in m.m.u. $\pm$ μ.m.u.) were derived; $H^1 - 1 = 8{\cdot}1459 \pm 0{\cdot}5$, $D^2 - 2 = 14{\cdot}7444 \pm 0{\cdot}9$, $He^4 - 4 = 3{\cdot}8797 \pm 1{\cdot}6$, $C^{12} - 12 = 3{\cdot}8231 \pm 3{\cdot}3$ and from a wider doublet $N^{14} - 14 = 7{\cdot}5150 \pm 4{\cdot}9$. With these mass differences and the binding energy of the deuteron, the neutron mass, the binding energies of the nuclei He^4, C^{12}, N^{14}, O^{16} and other nuclear data are calculated. J. HUGHES

539.156

8548. Determination of forces acting between atoms with the use of the differential cross-section of elastic scattering. O. B. FIRSOV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 279–83 (1953) *In Russian.*

See *Phys. Rev.*, **52**, 1238–44 (*Dec.* 15, 1937). The interaction potential for colliding particles is determined from the relationship given between the angle of scattering α and the collision parameter p. A method is indicated whereby $\alpha(p)$ can be determined from the measured value of differential cross-section of elastic scattering. An example illustrates the use of the formulae derived, and the case of forces of varying sign (attraction at greater, and repulsion at smaller, distances) is discussed in detail. F. LACHMAN

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16

8549. Isotopic composition and radioactivity of recent lead from Vesuvius. F. BEGEMANN, J. GEISS, F. G. HOUTERMANS AND W. BUSER. *Nuovo Cimento*, **11**, 663–73 (*June*, 1954) *In German.*

Lead from 3 samples of cotunnite ($PbCl_2$) from Vesuvius was examined. The radioactivity was established as due to RaD and its daughter products ($21{\cdot}2 \pm 0{\cdot}5$ disintegrations per sec per mg Pb) extrapolated to the time of discovery. The lead appears to be a new "intermediate" type, containing $\sim 0{\cdot}7\%$ radiolead, from a uranium concentrate of age $> 17 \times 10^6$ yr, the remainder being "ordinary" lead of recent age. The isotopic ratios show an anomaly similar to that of lead from Joplin, Sudbury, etc.; a mechanism for the formation of these J-types is suggested. A. O. STANESBY

539.16 : 537.531

8550. On the angular correlation between a nuclear radiation and X-radiation in coincidence. P. BENOIST. *C.R. Acad. Sci.* [*Paris*] **238**, 1498–9 (*April* 5, 1954) *In French.*

It was found theoretically that only the L_{III} radiation gives a weak anisotropic correlation. J. HUGHES

539.16.08

8551. Comparative sensitivities of different procedures for the estimation of radiocarbon. M. REINHARZ, G. ROHRINGER AND E. BRODA. *Acta phys. Austriaca*, **8**, *No.* 3, 285–8 (1954) *In German.*

A concise critical discussion of the relative advantages and sensitivities of the different available methods, excluding scintillation counters.

A. O. STANESBY

539.16.08

8552. Determining mesothorium content of thorium nitrate. M. ALLISON, R. W. MOORE, A. E. RICHARDSON, D. T. PETERSON AND A. F. VOIGT. *Nucleonics*, **12**, 32–4 (*May*, 1954).

The Ra^{228} content of thorium samples is deduced from measurements of the activity of the β-emitting daughter product Ac^{228}. The actinium is separated out in the presence of a lanthanum carrier and its 6·1 hr activity is measured over two or more half-lives. Checks on the completeness of the Ac recovery are necessary. L. R. SHEPHERD

539.162

8553. Rotation levels and spectra of heavy nuclei. S. G. RŸZHANOV. Letter in *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 361–2 (1953) *In Russian.*

Provides mathematical basis for the idea expressed in a previous paper [Abstr. 5670 (1953)], viz. that the 3 different values of rotation constant B (15, 20 and 26·5 keV) are related to nuclear shells.

F. LACHMAN

539.163

8554. The total disintegration energy of the nuclides Al^{28} and Al^{29}, and the magic number 14. M. E. NAHMIAS. *C.R. Acad. Sci.* [*Paris*] **238**, 1875–6 (*May* 10, 1954) *In French.*

The energies, which are anomalous, have been rechecked experimentally. The product nuclides are either singly or doubly magic, but unusual disintegration energies are not observed when other nearby magic number nuclides are produced. J. M. CASSELS

539.163.1

8555. Half-life and beta decay of the long-lived niobium-94. M. A. ROLLIER AND E. SAELAND. Letter in *Phys. Rev.*, **94**, 1079 (*May* 15, 1954).

Nb^{94} prepared by pile irradiation of Nb_2O_5 was chemically separated from Ta activities. The 6·6 min isomeric β-emitting state of Nb^{94} was confirmed. Absolute β-counting of a known mass of Nb gave a value of $2{\cdot}7 \pm 0{\cdot}4 \times 10^4$ years for the half life of Nb^{94} and absorption measurements a maximum β-energy of 0·61 MeV. M. A. GRACE

539.163.1 : 539.152.1

Lifetime of excited states of F^{19}. *See Abstr.* 8527

539.163.2

8556. The radiation of Hf^{175} and Hf^{181}. A. A. BASHILOV, N. M. ANTON'EVA, B. S. DZHELEPOV AND A. I. DOLGINTSEVA. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 4, 437–67 (1953) *In Russian.*

Full analysis of β and conversion-electron spectrum from Hf_2O_3 (irradiated with slow neutrons) observed with an inhomogeneous magnetic field spectrometer and counter giving a resolving power of $(\Delta H\rho)/H\rho = 0{\cdot}6\%$ and covering the range 20–650 keV. The Kurie plot of the β-spectrum is linear from 150 keV to the max. of 405 ± 5 keV. In all, 17 conversion lines were observed which can be ascribed to 89·5 and 340 keV γ's from Lu^{175} and 132, 135, 344, 478, 607 keV γ's from Ta^{181}. Analysis of conversion coefficients leads to the assignments: $M1$, $M1 + E2$; $E2$, $M1$, $E2$ or $(M1 + E2)$, $E2$ or $M1 + E2$, $M3$ respectively. Intensities and numbers of quanta per β are deduced and discussed in detail. All the results are compared with those of other authors. An energy spectrum is drawn up for Ta^{181} as follows: Ground state $g_{7/2}$; 135 keV $+ \frac{7}{2}$, $<10^{-9}$ sec; 478 keV $d_{5/2}$, $1{\cdot}1 \times 10^{-8}$ sec; 607 keV $s_{1/2}$, $2{\cdot}2 \times 10^{-5}$ sec; Hf^{181} at 1012 keV. W. J. SWIATECKI

539.163.2

8557. The radiation of Zn^{65}. A. A. BASHILOV, N. M. ANTON'EVA, D. L. BRODER AND B. S. DZHELEPOV. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 4, 468–86 (1953) *In Russian.*

Using the spectrometer mentioned in the preceding abstract the β^+ energy was determined as 325 ± 2 keV. Conversion electrons for $h\nu = 1122 \pm 5$ keV with an intensity $(5{\cdot}5 \pm 0{\cdot}5) \times 10^{-13}$ per one β^+ were found. The ratio of β^+ to γ's was determined as $(3{\cdot}0 \pm 0{\cdot}2) \times 10^{-2}$ by comparing the photoelectrons from Pb produced by the γ's with those from the annihilation radiation of the β^+'s. The conversion coefficient leads to an $M1$ assignment. Comparison with previous work at every stage. The resulting decay scheme for (Ni^{65} and Zn^{65}) $\rightarrow Cu^{65}$ is consistent with spin assignments of the shell model and ft values. W. J. SWIATECKI

539.163.2

8558. An investigation of the radiation of Tb^{160}. L. YA. SHAVTVALOV. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 4, 503–6 (1953) *In Russian.*

Twin β-spectrometers and coincidence circuits were used to isolate that component of the composite β-spectrum (max. energy 590 keV) which is in coincidence with the 86 keV γ, detected through its 77 keV conversion peak in one of the instruments. The decay scheme is consistent with Cork [Abstr. 3918 (1948)] but not with Burson [Abstr. 4315 (1950)]. W. J. SWIATECKI

539.163.2

8559. Investigation of the nuclear isomerism of Zn^{69}, Nb^{95}, and Ba^{137}. V. M. DOLISHNYUK, G. M. DRABKIN, V. I. ORLOV AND L. I. RUSINOV. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 6, 1141–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-229.*

Beta-spectrometer measurements showed that isomeric Zn^{69} ($T_{\frac{1}{2}} = 13{\cdot}8$ hr) decays by γ-emission (439 ± 2 keV, $\alpha_K = 0{\cdot}04 \pm 0{\cdot}005$, $\alpha_K/\alpha_L = 7{\cdot}5 \pm 1$) to 57 min Zn^{69}, a β-emitter ($E_{max} = 920 \pm 20$ keV). Isomeric Nb^{95} ($T_{\frac{1}{2}} = 90$ hr) emits highly internally converted γ-radiation (220 ± 2 keV, $\alpha_K/\alpha_L = 4{\cdot}3 \pm 0{\cdot}1$). The β-decay of Cs^{137} ($E_{max} = 540 \pm 10$ keV) leads to an isomeric state ($T_{\frac{1}{2}} = 2{\cdot}6$ min) of Ba^{137} which decays to the ground state by a 661 ± 2 keV γ-ray ($\alpha_K = 0{\cdot}11 \pm 0{\cdot}01$, $\alpha_K/\alpha_L = 6{\cdot}0 \pm 0{\cdot}1$, $\alpha_L/\alpha_M = 4{\cdot}1 \pm 0{\cdot}2$). These γ-transitions are attributed to $M4$ multipoles and their transition probabilities are discussed in relation to the shell model. M. A. GRACE

539.163.2

8560. On the disintegration of Rh^{105}. C. LÉVI AND L. PAPINEAU. *C.R. Acad. Sci.* [*Paris*] **238**, 1407–9 (*March* 29, 1954) *In French.*

The β- and γ-radiations of neutron-irradiated Ru (purified from an interfering impurity of Ir) confirmed the complex β-decay of Rh^{105}: the max. β-particle energies were 530 (intensity 0·96) and 210 ± 15 keV (0·04), and the energy of the γ-radiation 320 ± 20 keV. Characteristic X-rays from the internal conversion of this γ-ray were sought but not found; $\alpha_K < 0{\cdot}05$. A. O. STANESBY

539.163.2

8561. Scintillation spectrometer measurements of the disintegration of Ti^{51}, Al^{28}, Mg^{27} and Cl^{34}. T. MAYER-KUCKUK. *Z. Naturforsch.*, **9a**, 338–46 (*April*, 1954) *In German.*

The measurements made use of 2 scintillation counters arranged to record γ-spectra, or β-γ- or γ-γ-coincidences. Ti^{51}: a γ-ray of 0·32 MeV was obtained [Abstr. 1872 (1953)]. Al^{28}: a suggested γ-radiation of 2·4 MeV could not be found. Mg^{27}: decay scheme comprising β-particle groups of E_{max} 1·6 and 1·7 MeV in coincidence with γ-rays of 1·0 and 0·84 MeV was confirmed [Abstr. 2698 (1954)]. Cl^{34}: the recently announced metastable state (half-life 1·45 sec) was confirmed [Abstr. 2669 (1954)]. A. O. STANESBY

539.163.2

8562. On the disintegration of $_{81}Tl^{204}$. T. YUASA, J. LABERRIGUE-FROLOW AND L. FEUVRAIS. *C.R. Acad. Sci.* [*Paris*] **238**, 1500–2 (*April* 5, 1954) *In French.*

The β^--particle spectrum was examined using very thin sources in a thick-lens magnetic spectrograph, giving $E_{\beta^-{}_{max}} = 765 \pm 10$ keV. No γ-rays nor internal conversion electrons were found. Weak Auger lines indicated a branching ratio $K/\beta^- \sim 4\%$. A. O. STANESBY

539.163.2

8563. Identification of californium isotopes 249, 250, 251 and 252 from pile-irradiated plutonium. H. Diamond, L. B. Magnusson, J. F. Mech, C. M. Stevens, A. M. Friedman, M. H. Studier, P. R. Fields and J. R. Huizenga. Letter in *Phys. Rev.*, **94**, 1083–4 (*May* 15, 1954).

Continuation of Abstr. 6870 (1954). Describes further results on these isotopes. Cf^{252} ($\frac{1}{2}$-life $2{\cdot}1 \pm 0{\cdot}4$ yr) decays by α-particle ($6{\cdot}12 \pm 0{\cdot}01$ MeV) emission, and by spontaneous fission (spontaneous fission $\frac{1}{2}$-life 60 ± 12 yr). A. O. STANESBY

539.163.2

8564. Nuclear properties of some isotopes of californium, elements 99 and 100. G. R. Choppin, S. G. Thompson, A. Ghiorso and B. G. Harvey. Letter in *Phys. Rev.*, **94**, 1080–1 (*May* 15, 1954).

Some details are given of the modes of decay of the isotopes Cf^{253}, $99^{253,254}$ and $100^{254,255}$ which have been prepared by neutron bombardment of Pu [Abstr. 5911 (1954)]. M. A. GRACE

539.163.2

8565. Existence of a $3{\cdot}7\times10^{-8}$-sec metastable state in Pa^{233}. D. Engelkemeir and L. B. Magnusson. Letter in *Phys. Rev.*, **94**, 1395–6 (*June* 1, 1954).

Stilbene scintillation counters were used to measure delayed coincidence in a source of Np^{237} between α-particles and conversion electrons: these showed a metastable state of $3{\cdot}69 \pm 0{\cdot}04\times10^{-8}$ sec half-life attributed to the 87 keV level in Pa^{233}. M. A. GRACE

539.163.2

8566. Study of the isobaric triplet Mg^{28} — Al^{28} — Si^{28}. R. K. Sheline, N. R. Johnson, P. R. Bell, R. C. Davis and F. K. McGowan. *Phys. Rev.*, **94**, 1642–51 (*June* 15, 1954).

The nuclide Mg^{28} has been produced by betatron irradiation and cyclotron bombardments in the following reactions: $Si^{30}(\gamma, 2p)Mg^{28}$ and $Mg^{26}(\alpha, 2p)Mg^{28}$. It is a $21{\cdot}3 \pm 0{\cdot}2$ hour β^--emitter ($E_{max} = 0{\cdot}418 \pm 0{\cdot}01$ MeV, $\log ft = 4{\cdot}30$). Mg^{28} decays to Al^{28} with which it is in secular equilibrium. Milking experiments indicate that the Al^{28} daughter has a 2·3 min half-life, and confirm the mass assignment of Mg^{28}. γ-ray spectra of the Mg^{28} — Al^{28} secular equilibrium mixture indicate γ-rays of the following energies in MeV (intensities in parentheses): $1{\cdot}769 \pm 0{\cdot}01$ (0·98), $1{\cdot}346 \pm 0{\cdot}01$ (0·70), $0{\cdot}949 \pm 0{\cdot}01$ (0·29), $0{\cdot}400 \pm 0{\cdot}01$ (0·31), $0{\cdot}0319 \pm 0{\cdot}001$ (0·96). The 1·769 MeV γ results from the decay of Al^{28}. Coincidence measurements show that the 1·346, the 0·949 and the 0·400 MeV γ's are each in coincidence with the 0·0319 MeV γ, and that the 0·949 and 0·400 MeV γ's are in coincidence with each other. Delay coincidence measurements between the 1·346 MeV γ and the 0·0319 MeV γ indicate that the half-life of the latter is $<2\times10^{-9}$ sec. This information together with the $\alpha^K_{exp} = 0{\cdot}032 \pm 0{\cdot}066$ indicates that the 0·0319 MeV γ is an $M1$ transition as predicted if the ground-state doublet of Al^{28} is a $j - j$ doublet. A complete decay scheme for the isobaric triplet, Mg^{28} — Al^{28} — Si^{28}, is proposed. All spins and parities of ground and excited states are assigned. Assuming a mass of $27{\cdot}985818 \pm 0{\cdot}000043$ a.m.u. for Si^{28}, the mass of Al^{28} is $27{\cdot}990809 \pm 0{\cdot}000045$ and the mass of Mg^{28} is $27{\cdot}992738 \pm 0{\cdot}000047$. On the basis of an empirical scheme of nuclear systematics the energy available for decay and the half-lives of the following nuclei are discussed: Si^{32}, Ne^{24}, O^{20}. A test for $j - j$ doublets is proposed. This test indicates that the ground state doublets of Al^{28} and P^{32} are true $j - j$ doublets, whereas the first excited state doublet of Al^{28} is not. A.

539.163.2

8567. Disintegration of Y^{91}. M. E. Bunker, J. P. Mize and J. W. Starner. *Phys. Rev.*, **94**, 1694–7 (*June* 15, 1954).

The radiations of the fission product Y^{91} have been investigated with β- and γ-scintillation spectrometers. In addition to the well-known $1{\cdot}55$ MeV ground-state β-transition, there is a weak (0·3%) β-transition of energy $0{\cdot}330$ MeV which is followed by a γ-ray of energy $1{\cdot}22 \pm 0{\cdot}01$ MeV. Definite assignment of these radiations to Y^{91} was established through exacting chemical procedures, measurement of the half-life of the γ-ray, and energy balance considerations. There is reason to believe that the $1{\cdot}22$ MeV level of $_{40}Zr^{91}$ is not a simple single-particle state. A.

539.163.2

8568. New neutron-deficient isotope of silver. B. C. Haldar and E. O. Wiig. *Phys. Rev.*, **94**, 1713–15 (*June* 15, 1954).

Silver-103 of 1·1-hour half-life, produced by bombarding silver with high-energy protons, was identified by following the decay with β-proportional, scintillation, and X-ray proportional counters and by milking the daughter, 17-day Pd^{103}, through seven half-lives. Measurements with a β-ray survey spectrometer showed the presence of conversion electrons of 0·6 MeV energy and positrons of 1·3 MeV maximum energy, both of which decayed with a half-life of 1·1 hours. Aluminium absorption measurements also gave 1·3 MeV as the maximum β^+-energy. Ag^{103} decays in part by K capture. A.

539.163.2

8569. Decay scheme of Co^{56}. M. Sakai, J. L. Dick, W. S. Anderson and J. D. Kurbatov. *Phys. Rev.*, **95**, 101–4 (*July* 1, 1954).

The decay scheme of Co^{56} was studied by means of a magnetic lens spectrometer and a γ-γ coincidence scintillation spectrometer. The positron spectrum consists of two groups of maximum energies of 1·50 MeV and 0·44 MeV, relative abundance of 96% and 4%, respectively, leading to a second and third excited state of Fe^{56}. Orbital electron capture also takes place involving several other excited states. Both of the β-ray spectra involved appear to have the "allowed" shape of the Fermi plot. The energies of the γ-rays emitted by the Fe^{56} nucleus were determined by studies of the photoelectron spectrum and scintillation spectrum. The energies determined were 0·845 MeV, 1·24 MeV, 1·75 MeV, 2·30 MeV, 2·60 MeV and 3·25 MeV, respectively. These γ-rays were fitted into the decay scheme by means of β-spectrum analysis and γ-γ coincidence experiments. A.

539.163.2

8570. Technetium activities at mass 97. G. E. Boyd. *Phys. Rev.*, **95**, 113–14 (*July* 1, 1954).

A technetium activity believed to be Tc^{97g} has been

observed to decay with molybdenum K X-rays and to possess a half-life in the range of 10^4 to 10^5 years. A.

539.163.2

8571. Further study of the decay scheme of Ir^{192}. R. W. PRINGLE, W. TURCHINETZ AND H. W. TAYLOR. *Phys. Rev.*, **95**, 115–16 (*July* 1, 1954).

Scintillation spectrometer studies have revealed four high-energy γ-ray components at 788, 883, 1080 and 1210 keV, with the possibility of a fifth component near 920 keV. The Ir^{192} — Pt^{192} ground-ground state transition energy has been measured as 1490 ± 20 keV. Level schemes are proposed for Pt^{192} and Os^{192}, the product nuclei upon the β-decay of Ir^{192}. A.

539.163.2

8572. Decay schemes of Cd^{114} and Te^{125}. D. C. LU, W. H. KELLY AND M. L. WIEDENBECK. *Phys. Rev.*, **95**, 121–2 (*July* 1, 1954).

Using the scintillation-crystal summing technique, coincidences between the γ-rays of Cd^{114} and of Te^{125} were studied. In the case of Cd^{114} no indications were seen of the existence of a 1·3 MeV and a 576 keV γ-ray previously reported. In the case of Te^{125}, the 176 keV γ-ray appeared not to be in coincidence with any other γ-rays. It must, therefore, end in a metastable state or the ground state. A.

539.163.2

8573. Disintegration of I^{126}. M. L. PERLMAN AND J. P. WELKER. *Phys. Rev.*, **95**, 133–7 (*July* 1, 1954).

The radiations from I^{126} have been investigated with a scintillation coincidence spectrometer; β-γ, γ-γ and x-γ events were studied. In a fraction of the electron-capture disintegrations, a γ-ray of energy 0·74 MeV was found to occur in cascade with the previously known 0·65 MeV γ-ray. The crossover transition also was observed. In a fraction of the negative β-decay processes, a γ-ray of energy 0·48 MeV occurs in cascade with the previously known 0·38 MeV γ-ray; in addition, the crossover transition was observed. The maximum energy of the positron spectrum and the relative intensities of all γ-transitions and of the annihilation radiation were measured. The intensity information, combined with the previously measured ratio of electron-capture probability to β-decay probability and with the ratio of the intensities of the 0·85 MeV and 1·24 MeV β-rays, is sufficient to give the abundances of all observed transitions in the decay scheme. Both the ft values and the measured ratio of electron-capture probability to positron-emission probability for the ground-state transitions indicate that I^{126} has spin 2 and negative parity. The shell structure assignments, neutron $h_{11/2}$ and proton $g_{7/2}$, are the only ones which can couple to give the resultant spin 2 and negative parity. A.

539.164

8574. The energies of natural alpha particles. G. H. BRIGGS. *Rev. mod. Phys.*, **26**, 1–6 (*Jan.*, 1954).

Gives recalculated values of the energies of natural α-particles which have been measured precisely by deflection methods. The results are based on the new values for the Faraday constant and the mass of the He^4 atom, a revised value for the author's absolute determination of the main group of RaC′ and weighted mean values for the main groups of ThC^{212}, ThC'^{212} and Po^{210}. A.

539.164

8575. On the fine structure of the α-particles of ionium. S. ROSENBLUM, M. VALADARES, J. BLANDIN-VIAL AND R. BERNAS. *C.R. Acad. Sci.* [*Paris*] **238**, 1496–8 (*April* 5, 1954) *In French.*

Using a magnetic spectrograph the following α-groups were observed from an isotopically pure source of ionium: $\Delta E = 0$. Intensity = 76·3; 67, 23·4; 142, 0·07; 215, 0·2; 250, 0·07; 328, 0·08; 399, 0·07; 485, 0·06. J. HUGHES

539.164 : 539.165

8576. Beta-alpha correlation in the decay of Li^8. S. S. HANNA, E. C. LAVIER AND C. M. CLASS. *Phys. Rev.*, **95**, 110–11 (*July* 1, 1954).

The β-α directional correlation in the $Li^8(\beta)$ $Be^{8*}(\alpha)He^4$ decay has been measured for various portions of the upper end of the β-spectrum, from about 90% to 10% of the total β-spectrum. No significant departure from isotropy was observed at the higher β-energies, as reported in earlier measurements. An average of the measurements gives a value of $A_2 = 0{\cdot}01 \pm 0{\cdot}03$ in the correlation function $1 + A_2 \cos^2 \theta$. A.

539.164 : 539.166

8577. Study of the α-γ angular correlation in Th^{230}(Io). I. Experimental results. P. FALK-VAIRANT, J. TEILLAC, G. VALLADAS AND P. BENOIST. *C.R. Acad. Sci.* [*Paris*] **238**, 1409–11 (*March* 29, 1954) *In French.*

With electron collection in a gridless α-particle ionization chamber (A–CO_2) the pulse-height $\propto$ cos (angle between direction of α-particle and axis of chamber); using a scintillation γ-counter on the axis in coincidence, the α-γ angular correlations were obtained for the 68 and 142 keV γ-rays and for the L X-radiation of Io. A. O. STANESBY

539.164 : 539.166

8578. Study of the α-γ angular correlation in Th^{230}(Io). II. Interpretation of results. P. BENOIST, J. TEILLAC, G. VALLADAS AND P. FALK-VAIRANT. *C.R. Acad. Sci.* [*Paris*] **238**, 1656–8 (*April* 21, 1954) *In French.*

The experimental results of Pt I are explained satisfactorily by assuming spins of 2 and 4 and even parity for the excited (rotational) levels of 67·8 and 210 keV of Ra^{226}, and the angular correlations to be reduced by coupling between the nuclear quadrupole moment of the intermediate state and the surrounding electric field. A. O. STANESBY

539.164 : 539.172.13

8579. The α-activity induced in gold bombardment with nitrogen ions. W. E. BURCHAM. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 555–9 (*June*, 1954).

Alpha-particle activities with half-lives varying from 6½ min to 10 day were found by means of an ionization chamber. The α-particle energies were measured by photographically recording the pulse heights using α-particles from Po^{210} for calibration. Active Em, As and Po isotopes were separated by chemical and physical methods and between them accounted for all the activity observed. Half-lives of 6·5 ± 0·5 and 11·0 ± 1·0 min in the emanation fraction were ascribed to Em^{206} and Em^{207}. J. H. FREMLIN

539.164.08 : 537.542

8580. Precision alpha-particle counting. K. M. GLOVER AND G. R. HALL. Letter in *Nature* [*London*] **173,** 991–2 (*May* 22, 1954).

Gives results of an experiment to compare methods of α-particle counting at Harwell and Berkeley. The Harwell method uses methane proportional chambers. The Berkeley method employs a ZnS–Ag phosphor and photomultiplier. Three plutonium sources, deposited on platinum disks were counted, and the results obtained by the two methods are in good agreement. P. ROTHWELL

539.164.83

8581. On the theory of Migdal. R. R. ROY AND M. L. GOES. *Bull. Acad. Roy. Belgique Cl. Sci.*, **40,** *No.* 2, 143–9 (1954) *In French.*

The probability of ionization during α-emission is calculated for Po^{210} using Migdal's theory, and compared with experimental results. General expressions for the electron energy distribution are given.

J. HUGHES

539.165/.166

8582. Short-lived isomeric states of Ag^{110} and In^{116}. F. I. BOLEY. Letter in *Phys. Rev.*, **94,** 1078–9 (*May* 15, 1954).

These were investigated using short (2 sec) neutron irradiations and a scintillation spectrometer as β- and γ-radiation detector. The 24 sec Ag^{110m} has a complex β-spectrum with at least 2 components of E_{max} 2·84 ± 0·05 and 2·16 ± 0·05 MeV; a consistent decay scheme is suggested. The 13 sec In^{116m} has a single β-spectrum with E_{max} 3·29 ± 0·06 MeV.

A. O. STANESBY

539.165/.166

8583. The disintegration of Rh^{102}. L. MARQUEZ. *Phys. Rev.*, **95,** 67–8 (*July* 1, 1954).

The disintegration of Rh^{102} has been investigated using a β-ray spectrometer. It was found that it decays by the emission of a negatron of end-point energy of 1150 keV and three positrons of end-point energies of 400 keV, 760 keV and 1240 keV. Five γ-rays were also found in its disintegration of 86 keV, 124 keV, 195 keV and 475 keV. A.

539.165

8584. The β-spectrum of Re^{186}. N. M. ANTON'EVA, A. A. BASHILOV, B. S. DZHELEPOV AND L. S. CHERVINSKAYA. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17,** *No.* 4, 507–10 (1953) *In Russian.*

Using the same apparatus as that mentioned in Abstr. 8556 (1954) the β-spectrum was found to consist of 2 components: 1060 ± 10 keV (73 ± 5%) and ~ 900 keV (27 ± 3%). Conversion peaks corresponding to γ's of 138·3 ± 0·5 keV (in Os^{186}), 123·4 ± 0·6 keV (in W^{186}) and 80 ± 1 keV?, 164 ± 2 keV? in Os? were measured. *K*, *L*, *M* conversion coefficients for the 138 keV line indicate an electric quadrupole. W. J. SWIATECKI

539.165

8585. Relative probability of positron emission and electron capture in the isotopes Na^{22}, Mn^{52}, Zn^{65}, Br^{77} and Tc^{93}. R. SEHR. *Z. Phys.*, **137,** *No.* 5, 523–44 (1954) *In German.*

Absolute methods were employed to obtain the number of capture- and positron-decays, using single and multiple G.M. counters and coincidence measurements. Na^{22}: branching ratio $N_+/(N_+ + N_e) = 0{\cdot}91_2 \pm 0{\cdot}04_8$. Mn^{52}: $0{\cdot}33_2 \pm 0{\cdot}02_6$. Zn^{65}: all the positron-decays go to the ground state, 48·5% of the capture-decays go to the excited state of Cu^{65}, and the branching ratio for ground-state transitions is $0{\cdot}038_5 \pm 0{\cdot}002_3$. Br^{77}: all positron- and 38% of the capture-decays are to the ground state, with a branching ratio $0{\cdot}023_5 \pm 0{\cdot}003_7$. Tc^{93}: $0{\cdot}012_2 \pm 0{\cdot}001$. The measured branching ratios are in good agreement with theory. A. O. STANESBY

539.165

8586. Measurement of the end point energy of positrons from Al^{25}. S. E. HUNT, W. M. JONES AND J. L. W. CHURCHILL. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67,** 479–80 (*May*, 1954).

Al^{25} was prepared by $Mg^{24}(p, \gamma)$ at a low bombarding energy where the yield of Al^{26} was negligible. Absorption in aluminium of the positrons showed an end point of 3·17 ± 0·15 MeV. M. A. GRACE

539.165

8587. Determination of maximum beta energy in the decay of Pb^{33}. B. ELBEK, K. O. NIELSEN AND O. B. NIELSEN. *Phys. Rev.*, **95,** 96–7 (*July* 1, 1954).

The maximum energy of the β-spectrum of P^{33} has been measured with sources prepared in two different ways. The first source was activated according to the method of Westermark. The second source was prepared in an isotope separator. The results were 252 ± 5 keV and 250 ± 5 keV respectively. A.

539.165

8588. Electron capture in K^{40}. J. HEINTZE. *Z. Naturforsch.*, **9a,** 469–72 (*May*, 1954) *In German.*

Direct experimental proof of argon *K*-radiation resulting from *K*-capture in K^{40} is obtained by using a large proportional counter-tube coated internally with a thin layer of K_2CO_3. The frequency, n_K, of the *K*-capture per g of K is 1·42 ± 0·23 per sec. Comparison of n_K with the number per sec of all capture processes (leading to excited levels of A^{40}) gives $n_L/n_K = 1{\cdot}35 \pm 0{\cdot}23$, but energy considerations suggest that it must be mainly *p*-electrons which are involved in the *L*-capture, a conclusion in agreement with the calculations of Marshak [*Phys. Rev.*, **61,** 431–49 (*April* 1–15, 1942)]. W. GOOD

539.165

8589. Double vacancies in the *K* shell associated with *K*-electron capture in A^{37}. J. A. MISKEL AND M. L. PERLMAN. *Phys. Rev.*, **94,** 1683–7 (*June* 15, 1954).

The pulse-height spectrum produced by the decay of A^{37} in a proportional counter was analysed to determine the probability, per *K*-electron capture, for the production of a double vacancy in the *K* shell. The double vacancy is produced by promotion of the second *K* electron to a bound state or to the continuum. In these experiments both processes could be observed; the measurements included events in which the kinetic energies of the promoted electrons were in the range zero to 4·0 keV. Seventy-three per cent of the theoretically predicted total effect should occur in this energy interval. The data, appropriately corrected, give for the probability of double *K*-vacancy production per *K* capture, in the energy interval

investigated, $3{\cdot}9 \pm 0{\cdot}7 \times 10^{-4}$. The result is substantially in agreement with the value calculated from theory. A.

539.165

8590. Search for anomalous positively charged particles from P^{32}. G. W. McClure. *Phys. Rev.*, **94**, 1637–40 (*June* 15, 1954).

With a small β-ray spectrometer of unique design, the electrically charged emanations of radioactive P^{32} have been analysed in an attempt to verify evidence found by others of the emission of positively charged particles in concentrations of the order of 10^{-3} to 10^{-4} per β-decay. The ratio of the yield of positively-charged particles to that of negatively-charged particles in the momentum interval $H\rho = 700$ to 2700 gauss cm was found to be less than 8×10^{-6}. This ratio is about 100 times smaller than earlier determinations in the same momentum interval obtained with cloud chambers and small spectrometers, but agrees in order of magnitude with a previous result obtained with an ordinary-sized spectrometer. The hypothesis that the anomalous "positive particles" in question are unstable and detectable only at short distances from the source would account for a low positive-particle yield measured with an ordinary spectrometer but cannot account for the disparity between the present results and those arrived at repeatedly with cloud chambers and other "short path length" detectors. It appears that the previously reported [e.g. Abstr. 6726 (1952)] "positive particle" ratios in the range 10^{-3} to 10^{-4} arise from spurious background effects. A.

539.165.08

8591. Photographic detection and dosimetry of beta rays. R. A. Dudley. *Nucleonics*, **12**, 24–31 (*May*, 1954).

Experiments were carried out with several different emulsions to determine the dependence of their dosage sensitivity upon angular distribution and energy of the electrons from the active sample. The effect of thickness of absorbers, placed between the emulsion and β-source, was also studied. Dosage sensitivity for perpendicularly incident electrons was found to increase rapidly with energy up to about 100 keV and to be substantially independent of energy above 500 keV. Diffuse incidence gave a slower increase of sensitivity with energy up to a flat maximum at about 1 MeV. Absorbers placed between the emulsion and a continuous β-source produced very little effect on the sensitivity of the emulsions. L. R. SHEPHERD

539.165.2

8592. β-disintegration of the nuclei of the type $_zM^{2z-1}$. D. Ivanenko and S. Larin. Letter in *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 359–61 (1953) *In Russian.*

See Abstr. 4966 (1949). Compares the *R-Z* curves obtained by 4 methods: (1) $R = 1{\cdot}5 \times 10^{-13} \times M^{\frac{1}{3}}$ cm; (2) from total cross-sections [see Abstr. 3029 (1951)]; (3) radii of "mirror" nuclei obtained from the energy of the β-disintegration and (4) from α-disintegration. Kinks in the curves [particularly in (3) and (4)] coincide with some of the known critical numbers of nucleons ($Z = 8$, 14, 20, 28, 50, 82, 90). The divergences between the curves are discussed. F. LACHMAN

539.165.2

8593. Beta-decay interactions. H. Brysk. Letter in *Phys. Rev.*, **94**, 1794–5 (*June* 15, 1954).

An upper limit is found to the strength of the pseudoscalar interaction, consistent with observed *ft* values. No such interaction can be detected. P. T. MATTHEWS

539.165.2

8594. Second-order corrections to beta spectra. P. F. Zweifel. *Phys. Rev.*, **95**, 112 (*July* 1, 1954).

The origin of small correction terms to β-spectra is discussed. The second-order corrections to allowed spectra are presented for both pure interactions and linear combinations. A.

539.165.2

8595. A β-decay matrix element for a deformed core model. M. G. Redlich and E. P. Wigner. *Phys. Rev.*, **95**, 122–6 (*July* 1, 1954).

The *ft* value for an allowed unfavoured β-transition, calculated on a deformed core + single-particle model, is $\leqslant 3$ times the single-particle value and about 4% of the observed value. The deformations of initial and final states were based on their quadrupole moments. The calculation indicates that for this model core orthogonality generally does not account for the difference between allowed favoured and unfavoured *ft* values. A.

539.165.2

8596. Shape factors for β-decay. M. K. Banerjee and A. K. Saha. *Proc. Roy. Soc. A*, **224**, 472–87 (*July* 22, 1954).

Expressions for the shape factors of the *L*th degree of forbidden β-transition were given by Greuling (1942) for the pure interactions and by Pursey [Abstr. 1204 (1952)] for different mixtures of the pure forms. The same results are derived here by a method due to Spiers and Blinstoyle [Abstr. 408 (1953)] and formulated neatly in terms of three parameters, (*a*) ξ giving the spatial covariance, (*b*) η giving the spatial parity and (*c*) ζ giving the space-time parity. The results readily point out that the correct form of interaction in the β-processes is either a STP combination or a VA combination. It is concluded that the proper way of setting up the β-interaction is to require that all the Dirac covariants, whose scalar products appear in the Hamiltonian, must behave in the same way under space-time reflection. A brief sketch of the principal mathematical tools required in the method of Spiers and Blinstoyle is given. A.

539.166

8597. Angular correlation of γ-quanta of Ni^{60}, Ba^{134}, Cd^{114} and Ti^{48}. D. G. Alkhazov, I. Kh. Lemberg and A. P. Grinberg. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 4, 487–502 (1953) *In Russian.*

Correlations between successive γ's were determined with scintillators. After correction for finite angular resolution the following spin assignments were made (ground state first, γ-energies in keV): Ni^{60} (+0) (1332 keV) (+2) (1172 keV) (+4). Ba^{134} (+0) (602) (+2) (799) (+4) (566) (+5). Cd^{114} (+0) (448) (+2) (715) (+2). Ti^{48} (0) (1330) (2) (980) (4) (1000) (6). Some assignments are made difficult by inadequately elucidated decay schemes. If the ground state of Cs^{134} is 4+ it would be difficult to understand the log *ft*

value of 8·8 for the β-decay of Cs^{134} to the +4 level of Ba^{134}. W. J. SWIATECKI

539.166

8598. The γ-radiation of Cu^{64}. B. S. DZHELEPOV, N. N. ZHUKOVSKIĬ, V. P. PRIKHODTSEVA AND YU. V. KHOL'NOV. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 4, 511–17 (1953) *In Russian.*

Using a recoil-electron γ-spectrometer a line at 1·346 ± 0·014 MeV was found (in addition to the annihilation radiation of 0·511 MeV) with an intensity of 1 *hν* per 23·5 positrons. A comprehensive analysis of existing β^-, β^+, *K*-capture and conversion data leads to a consistent decay scheme for Cu^{64} which, however, gives a mass difference $Zn^{64} - Ni^{64} = 1·108 \pm 0·004$ MeV instead of the mass-spectroscopic 1·87 ± 0·07 MeV. W. J. SWIATECKI

539.166

8599. Gamma-rays from [454 keV] proton capture in ^{26}Mg. J. C. KLUYVER AND G. VERPLOEGH. Letter in *Physica*, **20**, 178–80 (*March*, 1954).

These have been studied with a scintillation spectrometer, and nine γ-rays of between 0·81 and 8·70 MeV energy are reported. A decay scheme is suggested. J. J. WILKINS

539.166

8600. Energy levels in W^{182}. C. M. FOWLER, H. W. KRUSE, V. KESHISHIAN, R. J. KLOTZ AND G. P. MELLOR. Letter in *Phys. Rev.*, **94**, 1082 (*May* 15, 1954).

Energy levels excited in the β-decay of Ta^{182} have been identified from β-spectrometer measurements on the γ-radiation. A level scheme incorporating about 40 γ-rays is suggested and some spin assignments are discussed. M. A. GRACE

539.166

8601. Gamma rays from Cu due to neutron inelastic scattering. L. A. RAYBURN, D. L. LAFFERTY AND T. M. HAHN. *Phys. Rev.*, **94**, 1641 (*June* 15, 1954).

Monoenergetic neutrons from the $H^2(d, n)He^3$ reaction were used to bombard a Cu scatterer in the form of a ring surrounding a γ-ray spectrometer. An analysis of the γ-spectrum obtained by subtracting the background counting rate from the counting rate with the Cu scatterer in place yields γ-rays with energies of 0·965, 1·110, 1·67, 1·91, 2·42 and 2·58 MeV. A.

539.166

8602. Gamma radiation from magnesium 26 under proton bombardment. L. N. RUSSELL, W. E. TAYLOR AND J. N. COOPER. *Phys. Rev.*, **95**, 99–101 (*July* 1, 1954).

Thin targets of Mg^{26} were bombarded with protons from a Van de Graaff generator. Fifteen well-defined resonance peaks were found in the proton energy region between 300 and 1500 keV. These resonances were attributed to the reaction $Mg^{26}(p, \gamma)Al^{27}$. The maxima of the resonances occur at proton energies of 343, 450, 662, 720, 813, 840, 954, 992, 1015, 1056, 1172, 1255, 1295, 1425 and 1464 keV. Measurement of the γ-ray energies from some of the stronger resonances indicate that the compound nuclei do not in most cases decay to the ground state by a single transition. A.

539.166 : 539.152.7

Angular distribution of gamma-rays from excited states of F^{19}. *See Abstr.* 8529

539.166 : 539.163.2

8603. Decay scheme and gamma-gamma correlations in B^{10}. S. M. SHAFROTH AND S. S. HANNA. *Phys. Rev.*, **95**, 86–91 (*July* 1, 1954).

Gamma-rays from the deuteron bombardment of beryllium were studied with two scintillation spectrometers operated in coincidence. Gamma-rays of energies 2·86, 2·15, 1·43, 1·02, 0·72 and 0·41 MeV, which have previously been associated with the B^{10} nucleus, were identified in single-channel spectra. Coincidences were observed between the following pairs of γ-rays: 2·86 — 0·72, 2·15 — 1·43, 1·43 — 1·43, 1·43 — 1·02, 1·43 — 0·72, 1·43 — 0·41, 1·02 — 0·72, 1·02 — 0·41 and 0·72 — 0·41. The decay scheme obtained from these measurements agrees with the one proposed by Ajzenberg, except for the presence of an additional 1·43 MeV transition between the 3·58 and 2·15 MeV states of B^{10}. A survey was made of the directional angular correlations between several of these coincident radiations. A.

539.166.08

8604. A γ-spectrometer with improved focusing. B. S. DZHELEPOV, N. N. ZHUKOVSKIĬ, A. A. KARAMYAN AND S. S. SHESTOPALOVA. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 4, 518–20 (1953) *In Russian.*

Improved focusing in a spectrometer of the type of Abstr. 3377 (1950) and 6433 (1951) achieved by using an inhomogeneous magnetic field was tested by determining the characteristics of the 1·17 and 1·33 MeV lines of the Co^{60} spectrum. W. J. SWIATECKI

539.166.08 : 537.542

A two-crystal gamma ray scintillation spectrometer. *See Abstr.* 8371

539.166.08 : 539.185.08

8605. How to use gas evolution for dosimetry of high gamma, neutron fluxes. E. J. HART AND S. GORDON. *Nucleonics*, **12**, 40–3 (*April*, 1954).

A dosimeter, based on the measurement of the amount of hydrogen and oxygen evolved during the decomposition of water by ionizing radiations, is described. Dilute aqueous solutions of KI (0·1 mM) are used, the KI preventing the back reactions from reducing the yields of H_2 and O_2. Boric acid is added for the purpose of neutron detection. Results of determinations of the constants relating the gas yields to the energy absorbed in the solutions, for Co^{60} γ-rays and thermal neutrons, are given. L. R. SHEPHERD

539.166.7

8606. Gamma-ray backscattering. G. J. HINE AND R. C. MCCALL. *Nucleonics*, **12**, 27–30 (*April*, 1954).

Experiments were carried out using a NaI crystal and pulse-height analyser to measure the energy distributions and comparative intensities of γ-rays backscattered by various materials, with Hg^{203} (280 keV), Cs^{137} (661 keV) and Co^{60} sources. Thickness and area of the backscatterer were varied and also the source to backscatterer distance (to distinguish between singly and multiply scattered radiations). High atomic number materials (Pb) were found to be poor backscatterers. L. R. SHEPHERD

539.166.74

8607. Interference of Rayleigh and nuclear Thomson scattering. A. M. CORMACK. *Phys. Rev.*, **94**, 1397–8 (*June* 1, 1954).

Born approximation and the Fermi–Thomas atomic model are employed in a discussion of the combined cross-section. G. E. BROWN

539.166.74

8608. Compton scattering. W. B. CHESTON. *Phys. Rev.*, **95**, 247–8 (*July* 1, 1954).

The canonical transformation of Bloch and Nordsieck is used to examine the infrared divergences present in double Compton scattering and radiative corrections to single Compton scattering. A.

539.166.8

8609. Inner bremsstrahlung in the electron capture process—Ge^{71}. B. SARAF. *Phys. Rev.*, **95**, 97–8 (*July* 1, 1954).

The spectral distribution of the inner bremsstrahlung of Ge^{71} has been studied at quantum energies as low as 20 keV. It was observed that the radiation intensity at energies less than ~100 keV is much larger than is indicated by currently available theory. The absolute radiative capture probability has been measured. This latter quantity and the spectral shape are in good agreement with theoretical considerations at energies greater than ~100 keV. A.

539.166.83

8610. The conversion spectrum of RaD. A. A. BASHILOV, B. S. DZHELEPOV AND L. S. CHERVINSKAYA. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 4, 428–36 (1953) *In Russian.*

This was measured in the range 1–1200 keV using an inhomogeneous magnetic field spectrometer and counter. $L_{I,II,III}$, M, N and O conversion electrons (from the 46·7 keV γ) were resolved (total number 58 ± 3 per 100 disintegrations). The L conversion coefficients indicate a magnetic dipole. Series of L and M Auger electrons were found around 2 and 8 keV. No γ-lines of 7·5 keV or electron lines of 31·9 keV, reported by some authors, could be confirmed. W. J. SWIATECKI

539.166.83

8611. Auger electrons from the *L*-shell in mercury. I. BERGSTRÖM AND R. D. HILL. *Ark. Fys.*, **8**, *Paper* 2, 21–6 (1954).

The energies (accuracy $\pm 0{\cdot}1\%$) and relative intensities (accuracy $\pm 30\%$) of 6 Auger lines have been measured with a 180° magnetic spectrometer. Empirical estimates of L-binding energies in already once-ionized atoms are discussed. J. J. WILKINS

539.166.83

8612. Natural widths of the internal conversion lines of RaB. M. MLADJENOVIĆ. *Ark. Fys.*, **8**, *Paper* 3, 27–48 (1954).

A 50 cm double focusing spectrometer was used (at 0·043% and 0·063% resolution) to measure the widths of the A, F, G, G_α, H, H_α and I lines. The results show that K line-widths exceed L line-widths by 80–100 eV. Possible causes of this difference are discussed. J. J. WILKINS

539.166.832

8613. An investigation of the Compton secondaries from RaC gamma-rays. M. MLADJENOVIĆ AND A. HEDGRAN. *Ark. Fys.*, **8**, *Paper* 4, 49–63 (1954).

Using a 50 cm double focusing spectrometer, 11 γ-rays were detected in the range 0·61–2·43 MeV. Relative intensity values are given. J. J. WILKINS

539.166.832

8614. Magnetic internal Compton coefficients in the Born approximation. L. SPRUCH AND G. GOERTZEL. *Phys. Rev.*, **94**, 1671–8 (*June* 15, 1954).

The absolute and relative probabilities of a nuclear transition in which there is a simultaneous ejection of a K electron and emission of a γ-ray has been calculated quantum-mechanically for the case in which the virtual radiation field is a 2^L magnetic multipole. The process will be referred to as an internal Compton effect. The Born approximation has been used and hence the calculations are expected to be valid only if the nuclear charge Z is small and the nuclear energy level separation large. The ratio of the number of continuous energy γ-rays to the number of discrete energy K electrons is independent of the nuclear matrix element and decreases as Z or as L increases. This is true for any energy range and any angular range of the continuous energy γ-rays, where the angles are measured with respect to the coincident continuous energy K electron. The angular distribution is most sensitive to L for comparable electron and γ-ray energies and for large angular separation. These conclusions are not much affected by inclusion of the L shell. In the limit of small γ-ray energies, the results reduce to those predicted by semiclassical theory. A.

539.166.835

8615. Contributions of bremsstrahlung conversion in trident experiments. M. M. BLOCK AND D. T. KING. *Phys. Rev.*, **95**, 171–4 (*July* 1, 1954).

Determinations of the cross-section for the direct creation of electron pairs by energetic charged particles in nuclear emulsions are dependent on the experimental criteria by which the observations are accepted, phenomenologically, as tridents. This paper discusses the extent to which materialization of a bremsstrahlung photon close to the path of the parent particle becomes experimentally indistinguishable from direct pair production. A study of 200 pairs arising from the conversion of bremsstrahlung photons from electrons with energies between 0·1 and 10 BeV leads to the conclusion that about 6% of the pairs materialize so close to their parent that they would be interpreted as tridents. An extension of the analysis to electrons of incident energy 100 BeV demonstrates that under typical experimental conditions about 70% of such secondary pairs would be accepted as tridents. Recently reported experiments which indicate a cross-section for direct pair production by fast electrons much larger than that predicted by theory are discussed. A.

539.167.3

8616. A convenient source of gamma radiation. D. F. SAUNDERS, F. F. MOREHEAD, JR AND F. DANIELS. *J. Amer. Chem. Soc.*, **75**, 3096–8 (*July* 5, 1953).

A simple irradiator is described which gives intense and uniform γ-radiation from Co^{60} for laboratory experiments involving objects of relatively small size.

It takes the form of a hollow Co^{60} cylinder into which the samples to be irradiated are placed. A.

NUCLEAR REACTIONS 539.17

539.172

8617. Nuclear events at high energies. J. V. Lepore and R. N. Stuart. *Phys. Rev.*, **94**, 1724–7 (*June* 15, 1954).

The statistical model, introduced by Fermi, is used to calculate the probabilities for various nuclear events at high energies. A general method for evaluating the phase integrals is proposed and used to find to some extent the consequences of neglect of pion momentum conservation. The effect of pion indistinguishability is studied and tables giving the probabilities for various processes are presented together with the energy spectra of the corresponding final nucleons. A.

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 8402

539.172

8618. Interaction of high-energy pions with nuclei. E. D. Courant. Letter in *Phys. Rev.*, **94**, 1081–2 (*May* 15, 1954).

Optical model calculations of the absorption cross-sections were made for 700 MeV $\pi^{\pm}$ on Pb, represented by (*a*) uniformly distributed neutrons and protons and (*b*) neutrons confined to a sphere $(N/Z)^{\frac{1}{3}}$ times the proton sphere (compare Johnson and Teller, 1954). Experiments on these lines could give information about the density distributions. W. J. Swiatecki

539.172

8619. Angular distribution of charge-exchange scattering of 40-MeV π^- mesons by hydrogen. J. Tinlot and A. Roberts. *Phys. Rev.*, **95**, 137–46 (*July* 1, 1954).

The angular distribution of the reaction $\pi^- + p \rightarrow \pi^0 + n$ has been measured at a mean π^- energy of 40 MeV by detecting coincident photons corresponding to π^0 emission at approximately 0°, 90° and 180°. The result is $d\sigma^0/d\Omega = (0{\cdot}45 \pm 0{\cdot}07) - (0{\cdot}98 \pm 0{\cdot}13)\cos\theta + (0{\cdot}54 \pm 0{\cdot}21)\cos^2\theta$ mb/sterad. The corresponding total cross-section is $\sigma_t^0 = 7{\cdot}9 \pm 1{\cdot}8$ mb. An analysis of this result and of previous measurements on π^+ and π^- scattering at 37 MeV has been made, following the hypothesis of charge independence. It is possible to find two distinct types of solution. One type has positive $T = \frac{1}{2}$ *s*-wave and $T = \frac{3}{2}$ *p*-wave phase shifts, and negative $T = \frac{3}{2}$ *s*-wave and $T = \frac{1}{2}$ *p*-wave phase shifts. For the other type, the signs of the phase shifts are almost all reversed. Each type consists of a pair of solutions which are intrinsically indistinguishable at low energies because of the impossibility of determining the sign of the spin-flip scattering amplitude. A choice between the two types of solution is in principle possible with improved data. Predictions of the angular distributions of π^- elastic scattering are made. A.

539.172

8620. Interaction of negative pions with iodine. L. Winsberg. *Phys. Rev.*, **95**, 198–204 (*July* 1, 1954).

The interaction of slow negative pions with iodine was studied radiochemically. From the yields of twenty-five radioactive nuclides, yield distribution curves were obtained for the isotopes of each of the seven elements preceding iodine in the periodic table. The total yields of each element and the displacement in mass units of the peak of each distribution from the line of maximum stability were found to be: Te 58% (−3), Sb 22% (−2), Sn 11% (0), In 3% (+1), Cd 0·7% (+1), Ag 0·12% (+2) and Pd 0·03% (+3 estimated). The sum of these yields accounts satisfactorily for essentially all the interactions of slow negative pions with iodine. The results reported here are compared with those of other investigations. A.

539.172

8621. Interaction of negative muons with iodine. L. Winsberg. *Phys. Rev.*, **95**, 205–9 (*July* 1, 1954).

The interaction of negative muons with iodine was studied radiochemically. The yield of the $I^{127}(\mu^-, \nu)Te^{127}$ reaction was determined to be $8{\cdot}2 \pm 1{\cdot}6\%$. The sum of the yields of all antimony isotopes is approximately 1%. From the yield of 58 day $Te^{125}{}_m$ and upper limits to the yields of 104 day $Te^{123}{}_m$ and 6 day Te^{118}, yield distribution curves were drawn to fit the extremes of the experimental errors. The multiplicity was thus determined to be $1{\cdot}7 \pm 0{\cdot}4$ neutrons per muon captured. A yield distribution curve which best fits the data is presented. A.

539.172 : 539.152.1

8622. Mu-mesonic X-rays and the shape of the nuclear charge distribution. D. L. Hill and K. W. Ford. *Phys. Rev.*, **94**, 1617–29 (*June* 15, 1954).

Mu-mesonic X-rays, fast electron scattering and electronic spectra each depend on the nuclear charge distribution $\rho(r)$ in different ways. Adjoining theoretical analyses of observations on these different phenomena may therefore bracket an acceptable set of functional descriptions for $\rho(r)$. The present paper reports the dependence of the μ-mesonic X-ray spectrum of Pb on the extent and shape of the nuclear charge density. For several functional families representing conceivable forms for $\rho(r)$ the authors have obtained the resultant Coulomb potentials and have solved "exactly" by electronic computation the relativistic equations to yield the first four levels ($1S$, $2S$ and $2P$) and transition energies for μ-mesons bound in the field of the lead nucleus. The next two levels ($3D$) have been found by perturbation theory. Effects omitted from the calculations have been examined and theoretical uncertainties estimated for each level. These results permit adjustment of the effective electric radius R, for each form of $\rho(r)$ to agree with known X-ray measurements of the $2P \rightarrow 1S$ transitions. Calculations completed for neighbouring values of R permit interpolation to improved values when more precise measurements are made and when small corrections of the raw data for electrodynamic and special coupling effects have been carried through. The doublet splitting of the $2P$ levels offers an independent measure of R, as well as a check on the possible existence of an anomalous muon magnetic moment. In contrast, the $3D \rightarrow 2P$ and $2S \rightarrow 2P$ transition energies are insensitive to R but sufficiently sensitive to the shape

of the charge distribution, so that accurate measurements of the transition energies between the six lowest muon levels in the heavy nuclides will be able to provide information on both the electrical radius and the shape of nuclear electrification, independently of indications from the other phenomena mentioned above. A.

539.172 : 539.152.1

8623. Nonuniform nuclear charge distributions and measurements of nuclear electrical radius. K. W. FORD AND D. L. HILL. *Phys. Rev.*, **94**, 1630–7 (*June* 15, 1954).

The dependence of three long-wavelength electronic effects and of the nuclear Coulomb energy on the size and shape of the electrical charge distribution in heavy nuclei is examined. It is noted that the X-ray fine structure effect and the isotope shift effect measure the volume integral of $r^2\sigma$ weighted by the nuclear charge density. $[\sigma = \{1 - (\alpha Z)^2\}^{\frac{1}{2}}]$. An earlier result of Feshbach—that medium-energy electron scattering measures the similarly weighted mean value of r^2—is derived more simply. For these electronic effects, therefore, exact calculations for one shape of charge distribution may easily be scaled to other shapes. The nuclear Coulomb energy has no such simple dependence, but measures very roughly the weighted mean value of $r^{0.8}$—nearly the same quantity as measured by the $2P \rightarrow 1S$ μ-mesonic transition in heavy nuclei. The nuclear Coulomb energy sheds no light on the shape of the nuclear charge distribution because of its inherent insensitivity to change of shape. The X-ray fine structure, and the atomic isotope shift, cannot give detailed information about the nuclear charge distribution because of uncertainty in the magnitude of radiative corrections, and of nuclear compressibility, respectively. Medium energy electron scattering results, coupled with μ-mesonic X-ray results, will in principle be able to delineate shapes. Present evidence from this source suggests a charge distribution nearly uniform or somewhat peaked toward the edge of the nucleus. A.

539.172

8624. Nuclear scattering of high-energy electrons. J. H. SMITH. *Phys. Rev.*, **95**, 271–6 (*July* 1, 1954).

The Born approximation is used to calculate matrix elements for the elastic and inelastic scattering of high-energy electrons by nuclei. Curves and simple numerical relations are given to describe the manner in which scattered amplitudes depend upon nuclear characteristics. A.

539.172.11 : 539.152.1

Coulomb excitation of F^{19} by α-particles. *See Abstr.* 8528

539.172.13

8625. The coupling of angular momenta in the reaction $^{27}Al(p, \gamma)^{28}Si$. P. J. GRANT. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 392–3 (*April*, 1954).

The angular correlation of the reaction $Al^{27}(p, \gamma)Si^{28}$ at the two resonances produced by protons of energy 630 keV and 652 keV have been found to be: $W_{exp}(\theta) \simeq 1 - 0{\cdot}12\cos^2\theta$ and $W_{exp}(\theta) \simeq 1 - 0{\cdot}48\cos^2\theta$ respectively. The ground state of Al^{27} is assumed to be d 5/2, and the two angular distributions are in agreement with calculations assuming L-S coupling and values of F equal to 5/16 and 0 respectively, where F is defined as the ratio (number of states formed via channel spin 3)/(number of states formed via channel spin 2). The levels formed are $^3F_3(-)$ and $^1D_2(-)$ respectively. Levels formed by resonances produced by protons of energy 404 keV, 503 keV and 677 keV on the basis of L-S coupling are $^3F_4(-)$, $^1D_2(+)$ and $^3D_3(+)$ respectively. D. R. CHICK

539.172.13

8626. Polarization of the 10·4 MeV gamma-ray in the reaction $^{27}Al(p, \gamma)^{28}Si$. I. S. HUGHES AND P. J. GRANT. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 481 (*May*, 1954).

Observations made with deuterium-loaded nuclear emulsions (as γ-ray detectors) indicate an electric-dipole transition. J. J. WILKINS

539.172.13

8627. Polarization of high-energy protons scattered by complex nuclei. S. TAMOR. Letter in *Phys. Rev.*, **94**, 1087–8 (*May* 15, 1954).

This problem can be formulated in terms of nucleon-nucleon collisions in the spirit of the impulse approximation. Polarizations at 15, 22½, 30° in p-d and p-α scatterings at 240 MeV are given, as deduced from n-p and p-p phase shifts. W. J. SWIATECKI

539.172.13

8628. Polarization of fast protons scattered by nuclei. G. TAKEDA AND K. M. WATSON. Letter in *Phys. Rev.*, **94**, 1087–8 (*May* 15, 1954).

Expressions for small-angle polarizations in p-p and elastic p-nucleus scatterings are deduced, the latter in the impulse approximation, in terms of the nucleon-nucleon scattering amplitudes. W. J. SWIATECKI

539.172.13

8629. Polarization by p-p collisions at 439 MeV. H. G. DE CARVALHO, E. HEIBERG, J. MARSHALL AND L. MARSHALL. Letter in *Phys. Rev.*, **94**, 1796–7 (*June* 15, 1954).

Measurements are reported of the asymmetry of scattering of a 50% polarized beam of protons on liquid hydrogen. Results differ little from those at 340 MeV [Abstr. 6677 (1954)] and 310 MeV [Abstr. 6878 (1954)]. P. T. MATTHEWS

539.172.13

8630. Polarization of elastically scattered nucleons from nuclei in the Born approximation. W. HECKROTTE. Letter in *Phys. Rev.*, **94**, 1797–8 (*June* 15, 1954).

The polarization of high-energy nucleons elastically scattered from nuclei has been interpreted in terms of an additional spin-orbit nuclear potential. It is shown that the Born approximation for the polarization is independent of the shape of the nuclear potential if the spin-orbit part is taken to be the gradient of the usual central potential. P. T. MATTHEWS

539.172.13

8631. Radiochemical evidence for the $Cu^{65}(p, p\pi^+)Ni^{65}$ reaction. S.-C. FUNG AND A. TURKEVICH. *Phys. Rev.*, **95**, 176–8 (*July* 1, 1954).

A study of the formation of the radioactive nickel isotopes in the irradiation of copper foil with high-energy protons has shown the presence of 2·56 hr Ni^{65}. The energy-dependence of the cross-section for the formation of this species, and its recoil properties,

indicate that it is formed by the $Cu^{65}(p, p\pi^+)Ni^{65}$ reaction. A.

539.172.13

8632. 400-MeV neutron-proton scattering. A. J. HARTZLER AND R. T. SIEGEL. *Phys. Rev.*, **95**, 185–92 (*July* 1, 1954).

The angular distribution of neutron-proton scattering has been measured at a neutron energy of 400 MeV, with energy resolution of 7%. The counter telescope used to detect recoil protons was calibrated in an auxiliary experiment which also gave information about proton-proton scattering at several energies in the 400 MeV region. The *n-p* cross-section has the same general characteristics observed at lower energies, with a minimum at about 100° (c.m. neutron scattering angle) and a large exchange peak at 180°. The *p-p* results indicate an isotropic cross-section below 400 MeV, and a rise at small angles at 428 MeV. A.

539.172.13 : 519.2

8633. On the application of the Monte Carlo method to the study of the passage of high-energy nucleons through the nucleus. P. CÜER AND J. COMBE. *C.R. Acad. Sci.* [*Paris*] **238**, 1799–1801 (*May* 3, 1954) *In French.*

A Monte Carlo machine has been constructed to study the passage of 340 MeV protons through the nuclei of G5 emulsion. Light and heavy nuclei are treated separately. The method is three-dimensional and allowance is made for the momentum distribution in the nucleus. The values of the parameters which determine the path of a particular particle (momentum of struck nucleus, for example) are chosen at random, but in such a way that the ensemble of values chosen gives back the assumed distribution. P. T. MATTHEWS

539.172.13 : 539.152.1

8634. The determination of the energy of proton gamma resonances and their use to check theories of nuclear structure. I. S. E. HUNT. *Atomics* [*London*] **5**, 163–7, 186 (*June*, 1954).

The energy levels of a compound nucleus can be found from observing the yield of the (p, γ) reaction producing it as a function of the incident proton energy. Methods of measuring proton energies using resistance voltmeters, generating voltmeters and magnetic and electrostatic deflectors are discussed, and the electrostatic deflection method is found to be preferable if high absolute accuracies are required. Target techniques and methods of γ-ray detection are also briefly described. A.

539.172.13 : 539.152.1

Inelastic proton scattering from F^{19}. *See Abstr.* 8526

539.172.13

8635. On the determination of the excited states of Be^8 by the reaction $B^{10}(d, \alpha)Be^{8*}$. P. CÜER, J.-J. JUNG AND R. BILWES. *C.R. Acad. Sci.* [*Paris*] **238**, 1405–7 (*March* 29, 1954) *In French.*

A detailed analysis of the angular distribution of α-particles from this reaction, using nuclear emulsions (at $E_d = 1$ MeV) confirms the existence of excited states of Be^8 at 4·9 and 7·2 MeV. There is probably a further level at ~ 4 MeV; that at 2·9 MeV may be multiple. A. O. STANESBY

539.172.13

8636. Energy levels in ^{10}B and ^8Be. G. C. REID. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 466–8 (*May*, 1954).

A fast neutron counter was used to investigate the energy spectrum of neutrons from the $Be^9(d, n)B^{10}$ and $Li^7(d, n)Be^8$ reactions. The counter consisted of a triple coincidence proportional counter telescope recording those recoil protons from a thin film of polyethylene which were projected in the same direction as the neutron beam. Proton energies were measured by putting absorbers between the first and second counter. Six neutron groups were found in the $Be^9(d, n)B^{10}$ reaction of energies 1·50, 2·12, 2·78, 3·16, 4·34 and 4·86 MeV. The group of energy 2·12 MeV corresponds to a level in Be^{10} of $2{\cdot}88 \pm 0{\cdot}1$ MeV not previously established. A broad group of energy 9·9 MeV was found in the $Li^7(d, n)Be^8$ reaction corresponding to a level at $5{\cdot}44 \pm 0{\cdot}1$ MeV in Be^8. No significant evidence for a previously reported level at 4·9 MeV was found. D. R. CHICK

539.172.13

8637. Some remarks on radiative capture and stripping reactions. G. R. SATCHLER. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 471–4 (*May*, 1954).

Formulae for the angular distribution of γ-rays following nucleon capture or stripping reactions have been given previously [Abstr. 1706 (1954)] by the author for *L-S* or *j-j* coupling. The absolute values of the parameters appearing in these formulae are presented, and a possible treatment of intermediate coupling is indicated. P. T. MATTHEWS

539.172.13

8638. Correction to deuteron stripping cross sections. L. SCHECTER AND W. HECKROTTE. Letter in *Phys. Rev.*, **94**, 1086 (*May* 15, 1954).

Coulomb scattering effects at 190 MeV serve to broaden the differential stripping cross-section for $U(d, p)$ and decrease the total cross-sections by a factor of two, so allowing a weighted mean cross-section of $1{\cdot}4 \pm 0{\cdot}2$ barns to be determined from fitting the data of Schecter *et al.* D. R. CHICK

539.172.13

8639. Some (d, p) reactions in Ni and the statistical theory of nuclear reactions. W. W. PRATT. Letter in *Phys. Rev.*, **94**, 1086–7 (*May* 15, 1954).

The angular distributions of protons from the $Ni^{58}(d, p)Ni^{59}$ and $Ni^{60}(d, p)Ni^{61}$ reactions have been studied in the angular range 15° to 160°, using nuclear emulsion detection and a 3 MeV deuteron beam on a nickel foil target. The results do not exhibit the characteristic forward peak of the stripping reaction but curves calculated from the Wolfenstein statistical theory give good agreement with the experimental curves and lead to spin predictions for the final states involved in the reactions. These curves are calculated assuming single particle excitation and agree with the results better than those calculated assuming multiple particle excitation. D. R. CHICK

539.172.13

8640. The deuteron bombardment of oxygen. W. M. FAIRBAIRN. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 564–5 (*June*, 1954).

The differential cross-section for the reaction $O^{16}(d, p)O^{17}$ has been calculated for four cases. These have been chosen to correspond to previously measured results at deuteron energies of 7·73 MeV

and 19·1 MeV, for the ground- and first-excited state of O^{17} at particular angles. It is shown that the theoretical values are low and it is pointed out that the discrepancy may be resolved by including the proton-nucleon interaction. [See Abstr. 3840 (1954).] J. H. FREMLIN

539.172.13

8641. Theory of the (d, p) reaction. W. TOBOCMAN. *Phys. Rev.*, **94**, 1655–63 (*June* 15, 1954).

The Born approximation treatment of the (d, p) reaction is modified so as to eliminate integrations over the interior of the target nucleus where the distortion of the incident wave is most severe. This treatment yields the S. T. Butler result when certain additional physical assumptions are made. An approximate expression for the (d, p) cross-section is given in which (*a*) the Coulomb interaction is taken into account, (*b*) the effects due to the interaction of the deuterons and the protons with the target nucleus are expressed in terms of the boundary conditions for the wave-functions of these particles at the nuclear surface, and (*c*) the effects arising from the fact that the mass of the target nucleus is not infinite are not entirely neglected. The methods presented can be used to get the corresponding result for the (d, n) reaction. A.

539.172.3

8642. Cross sections for the reaction $^7Li(\gamma, p)^6He$ at 17·6 and 14·8 MeV and the first excited state of ^6He. E. W. TITTERTON AND T. A. BRINKLEY. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 469–71 (*May*, 1954).

The absolute cross-section of the reaction $Li^7(\gamma, p)He^6$ has been determined for $E_\gamma = 14·8$ MeV and $E_\gamma = 17·6$ MeV using lithium-loaded plates exposed to the resonance radiation from the reaction $Li^7(p, \gamma)Be^8$. 160 events were observed, and a number-total energy histogram plotted. When the results were compared with a theoretical fit to the distribution, a discrepancy was found in that there was an excess of events in the region of 16 MeV. It is suggested that this may be due to some of the He^6 nuclei being formed in an excited state. The energy difference of 1·6 MeV is in fair agreement with the value of 1·7 MeV found for the first excited state of He^6. A discussion of some results for the excitation curve of the reaction $Li^7(p, \gamma)He^6$ is given which lends some support to this theory. The cross-sections, in terms of the cross-section for $C^{12}(\gamma, 3\alpha)$ taken as $2·4\times10^{-28}$ cm^2 at 17·6 MeV, were found to be: $14·8Li^7(\gamma, p)He^6$ (ground state) $= (2·2 \pm 0·25)\times 10^{-27}$ cm^2. $17·6Li^7(\gamma, p)He^6$ (ground state) $= (6·8 \pm 0·9)\times10^{-28}$ cm^2. $17·6Li^7(\gamma, p)He^6$ (1·71 MeV state) $= (5·44 \pm 0·9)\times10^{-28}$ cm^2. D. R. CHICK

539.172.3

8643. The elastic scattering of photons. E. G. FULLER AND E. HAYWARD. Letter in *Phys. Rev.*, **94**, 732–3 (*May* 1, 1954).

Using a 50 MeV betatron and a scintillation spectrometer, the elastic scattering cross-sections for Au, Pb and U have been measured. All three cross-sections exhibit a resonance about 5 MeV wide, centred at 15 MeV. J. J. WILKINS

539.172.3

8644. Systematics of photoproton reactions. E. V. WEINSTOCK AND J. HALPERN. *Phys. Rev.*, **94**, 1651–4 (*June* 15, 1954).

The photoproton yields from the elements Ta, Pt, Pb, W and Au have been determined for betatron bremsstrahlung bombardment at 22 MeV peak energy by the use of zinc sulphide detectors and a 40 μsec betatron pulse duration. The yields, as measured in photoprotons per mole per roentgen, are as follows: Ta, $5·7\times10^4$; Pt, $2·9\times10^4$; Pb, $5·8\times10^4$; W, $5·2\times10^4$; and Au, $1·9\times10^4$. These values, along with previous determinations, permit a study of general behaviour of photoproton yields for all Z values throughout the periodic table. Comparisons with calculations based on the evaporation model show good agreement with experimental trends up to a Z of 50, after which the measured yields are too high by factors ranging from 10 to 10^4. Calculations based on the direct photoelectric process give better agreement. A.

539.172.3

8645. Deuteron photodisintegration at intermediate energies. J. M. BERGER. *Phys. Rev.*, **94**, 1698–713 (*June* 15, 1954).

The differential and total cross-sections for the photodisintegration of the deuteron are calculated for incident γ-ray energies in the range of 6 to 28 MeV. The following cases are treated: (1) Approximation I, in which shape-independent wave-functions are used corresponding to a 50% charge-exchange central force, (2) Approximation II-C, in which a central Hulthén potential with a variable percentage of charge exchange forces is used, (3) Approximation II-NC, in which approximate non-central Hulthén wave-functions and an approximate non-central Hulthén potential with 50% charge-exchange force, is used. In all these calculations, use is made (where possible) of a form for the interaction between the deuteron and radiation that gives the results of the interaction to all multiple orders automatically. The possible effect of exchange currents on the cross-sections is also estimated by a calculation making use of the phenomenologically derived exchange moments of Berger and Foldy. The numerical results of these calculations are used to estimate the uncertainty in the theoretically calculated cross-section at the present time. It is concluded that the uncertainty may be as large as 15% of the total cross-section for these energies. About 5% of this arises from experimental uncertainties in empirically determined parameters, while the remainder arises from ignorance of the exact form of the neutron-proton interaction. A.

539.172.4

8646. Neutron absorption cross section of U^{235} at 2200 m/sec. H. PALEVSKY, R. S. CARTER, R. M. EISBERG AND D. J. HUGHES. Letter in *Phys. Rev.*, **94**, 1088–9 (*May* 15, 1954).

A "chopped" pile beam and a time-of-flight technique were used. The result obtained was 691 ± 5 barns, considerably higher than previously accepted values. J. M. CASSELS

539.172.4

8647. Average neutron total cross sections in the 3- to 12-MeV region. N. NERESON AND S. DARDEN. *Phys. Rev.*, **94**, 1678–82 (*June* 15, 1954).

Measurements of the average neutron total cross-

sections of N, F, Mg, P, Cl, Ti, Mn, Co, Ni, Zn, Se, Br, Mo, Ag, Cd, Sn, Sb, Te, La, Ta, W, Au, Hg and Tl have been made over the 3 to 12 MeV energy range. The average energy spread of the measurements is approximately 10% and the over-all accuracy of the results is ±10% or better. The above data, together with those of a previous experiment, provide information on average cross-section behaviour as a function of energy and atomic weight over most of the periodic table. A.

539.172.4

8648. Thermal neutron capture cross section of carbon-13. G. R. Hennig. *Phys. Rev.*, **95**, 92–5 (*July* 1, 1954).

The thermal neutron capture cross-section of C^{13} has been determined from the amount of C^{14} formed in pile-irradiated samples of graphite, barium carbonate and carbon dioxide. Because of the impurity reaction, $N^{14}(n, p)C^{14}$, of comparatively high cross-section, the results were consistent only when samples were used which were enriched in C^{13}. The average isotopic cross-section determined for the enriched samples was $1{\cdot}4 \pm 0{\cdot}2$ millibarns. The final value of the cross-section in these samples corrected for the estimated residual nitrogen impurity is $0{\cdot}9 \pm 0{\cdot}2$ millibarn. A.

539.172.4

8649. Capture of polarized neutrons by polarized Sm^{149} nuclei. L. D. Roberts, S. Bernstein, J. W. T. Dabbs and C. P. Stanford. *Phys. Rev.*, **95**, 105–10 (*July* 1, 1954).

The Sm^{149} nuclei in the paramagnetic salt, samarium ethyl sulphate, were polarized by use of the hyperfine structure coupling, which was known to be large from paramagnetic resonance measurements. The Sm salt was placed in a field of 11 000 gauss after being cooled by thermal contact with a sample of iron ammonium alum which was demagnetized to zero field from 15 500 gauss and 1·2°K. The nuclear polarization was observed and measured by observations on the state of polarization of the neutrons transmitted by the Sm sample. A single crystal of magnetized magnetite, set to reflect neutrons of 0·07 eV in first order from the 220 planes was used as the analyser. A nuclear polarization of about 0·12 was deduced from the data. The observed polarization direction of the transmitted neutrons gives $J = I + \frac{1}{2}$ for the 0·094 eV resonance level in Sm^{149}. A temperature of about 0·13°K for the Sm-containing salt was deduced from the observed neutron polarization. A.

539.172.4

8650. Angular distribution and cross section of $Li^6(n, \alpha)H^3$ for neutrons of 1·1, 1·5, and 2·0 MeV. J. B. Weddell and J. H. Roberts. *Phys. Rev.*, **95**, 117–20 (*July* 1, 1954).

The angular distribution of $Li^6(n, \alpha)He^3$ has been determined for 1·1, 1·5 and 2·0 MeV neutrons by track measurements in 100-micron Ilford *C*2 and *E*1 lithium-six loaded emulsions. The triton yield function has been expressed as a finite series of spherical harmonics in the centre of mass system. The *s* and *p* components of the neutron wave appear to predominate in the reaction, but the data are not sufficiently accurate to exclude the possibility of contributions from higher angular momentum components. The cross-section was also determined for the reaction at neutron energies of 1·5 and 2·0 MeV relative to that at 0·60 MeV. This was done by exposing the same plate to 0·60, and to 1·5 or 2·0 MeV neutrons; a long counter was used to measure the neutron flux at each energy. Tracks were selected in a suitable cone so as to resolve the two energy groups. The results were $0{\cdot}32 \pm 0{\cdot}06$ and $0{\cdot}27 \pm 0{\cdot}04$ barn at 1·5 and 2·0 MeV, respectively. A.

539.172.4 : 539.163.2

8651. New isotopes of americium, berkelium and californium. A. Ghiorso, S. G. Thompson, G. R. Choppin and B. G. Harvey. Letter in *Phys. Rev.*, **94**, 1081 (*May* 15, 1954).

Neutron irradiation of Am^{243} and Bk^{249} yield the isotopes Am^{244}, Bk^{250}, Cf^{250} and Cf^{252}: details of their decay properties are given together with those of Cf^{249}. M. A. GRACE

539.172.4

8652. Fission product kilocurie source: preparation, radiation intensity. J. W. Loeding, E. J. Petkus, G. Yasui, W. A. Rodger, I. G. Dillon and L. Burris. *Nucleonics*, **12**, 14–20 (*May*, 1954).

The preparation of a radioactive source, from about 2000 curies of gross fission products set into a concrete cylinder, is described. The source is shielded by concrete and Pb and a dose rate of about 10^4 r/hr is obtained in a sample channel running through the axis of the source. The calculation of the radiation intensity in the sample hole is described. L. R. SHEPHERD

539.172.4

8653. Study of the variation of the effective fission cross-section of U^{235} in the thermal and epithermal region. P. Hubert, G. Vendryes and J.-M. Auclair. *C.R. Acad. Sci.* [*Paris*] **238**, 1873–5 (*May* 10, 1954) *In French.*

The fission cross-section and the $B^{10}(n, \alpha)Li^7$ cross-section were compared from 10^{-2} to 3 eV, using a crystal spectrometer to select monochromatic neutron beams. The fission cross-section shows resonances spaced about 1 eV apart. J. M. CASSELS

539.172.4

8654. On the analysis of experiments involving the kinetics of piles with reflectors. V. H. Rumsey. *Canad. J. Phys.*, **32**, 435–49 (*July*, 1954).

The theory of pile kinetics is used to analyse measurements of the mean lifetime and migration length of neutrons. The purpose is to show what effects need to be taken into account in the analysis of pile experiments rather than to give a precise experimental verification of the theory. It is shown that the bare-pile one-group model is not adequate. A two-group model which takes into account the presence of the reflector is used to obtain a more accurate analysis. The orders of magnitude are illustrated by deriving formulae for a specific pile—the Chalk River ZEEP. It is found that the presence of the reflector results in an increase of the mean lifetime T of about 20%. Increasing the multiplication constant k_∞ by a given amount produces a bigger value of effective multiplication constant k_e, for the pile with a reflector than without, but owing to the larger value of T, the pile with reflector diverges more

slowly than the bare pile. The bare-pile model overestimates by about 10% the change in k_∞ required to re-establish stability after a given change in k_e. The migration length is over-estimated by about 25%. The more elaborate theory agrees well with various measured values, but this is partly fortuitous because the structure of the ZEEP is rather complex and is not adequately represented in the theory. A.

539.172.4

8655. Energy distributions of fragments from fission of U^{235}, U^{238}, and Pu^{239} by fast neutrons. J. S. Wahl. *Phys. Rev.*, **95**, 126–32 (*July* 1, 1954).

The energies of fragments from fission of U^{235}, U^{238} and Pu^{239} by 14 MeV neutrons, from fission of U^{238} by 2·5 MeV neutrons, and from fission of U^{235} and Pu^{239} by thermal neutrons have been measured in a single Frisch grid ionization chamber. The energy distributions for fast neutrons are similar to those previously obtained for fission by thermal neutrons. The most probable energies of the light and heavy fragments for fission by 14 MeV neutrons do not change significantly from their values for slow-neutron induced fission. The valley between peaks is higher for fission induced by 14 MeV neutrons than for low-energy neutron-induced fission. A double Frisch grid chamber has been used to measure simultaneously the energies of both fragments from fission of U^{235} by 14 MeV neutrons. The main change in the distribution of fission modes from that for thermal-neutron-induced fission is the increased probability for symmetrical fission. A.

539.172.4

8656. Preparation of pure carbon for nuclear reactors. F. M. Bosch, A. J. Rutgers, J. Vidts, G. Geens, R. Roels and J. Poté. *Meded. K. Vlaamse Acad. Wetensch.*, **15**, *No.* 11, 12 *pp.* (1953) *In Dutch.*

This was done by the cracking of pure methane, first as a gas at 1500°C to get a pure powder, afterwards with a catalyst at 800°C to form a cake of high density and stability. A description of the apparatus used is given. C. TURNER

539.172.4

8657. The materials testing reactor. J. R. Huffman. *Nucleonics*, **12**, 20–6 (*April*, 1954).

The reactor is of the thermal neutron type using enriched U fuel with light water as moderator and coolant and a Be reflector, the assembly being contained in a long aluminium tank of 54½ in. diameter surrounded by a large volume of graphite. At an operating power of 30 MW, there is a maximum fast neutron flux of 10^{14} n/cm²/sec and a thermal neutron flux as high as 5×10^{14} n/cm²/sec in the Be, while fluxes over a large region in the graphite exceed 10^{13} n/cm²/sec. The inner zone of the graphite is made up of 700 000 1-in. diameter pebbles, which are free to expand and are readily discharged if damaged. Details of cooling, control elements, instrumentation and irradiation facilities are given. L. R. SHEPHERD

539.172.4

8658. Optimizing multiplication factors of heterogeneous reactors. I. C. Atkinson and R. L. Murray. *Nucleonics*, **12**, 50–3 (*April*, 1954).

A simplified procedure for calculating the optimum multiplication factors of heterogeneous reactors, using diffusion theory, is outlined. Approximations are introduced to avoid the use of higher order Bessel functions, thereby eliminating the need for special tables. L. R. SHEPHERD

539.172.4 : 518.5

8659. Using a reactor simulator for design analysis. R. B. Spooner. *Nucleonics*, **12**, 36–9 (*April*, 1954).

The simulator described gives a numerical integration of one-dimensional multigroup age-diffusion equations, permitting the calculation of criticality conditions and spacial distributions of neutron fluxes. A linear electrical resistance network is employed, the resistor values being chosen to correspond to appropriate nuclear parameters for neutrons in successive energy groups. Potentials at junction points in the network give the neutron fluxes, while resistor currents give the rates of absorption, slowing down, etc., in different volume elements for any given neutron group. L. R. SHEPHERD

539.172.4 : 539.166

8660. Gamma-ray spectrum of the bulk shielding reactor. F. Maienschein and T. Love. *Nucleonics*, **12**, 6–8 (*May*, 1954).

Gamma-ray energy spectrum measurements were made in the ORNL "swimming pool" reactor. The spectrometer was of the scintillation type using two NaI crystals, one measuring the energy of the Compton recoil electron and the other detecting the scattered photon, or three crystals, one measuring the kinetic energy of the electron-positron pair and the other two detecting the annihilation quanta. The crystals were placed inside a large lead container which allowed a narrow collimated beam from the reactor to fall on the energy-measuring crystal. The spectra of γ-radiation direct from the core reflector and also of the radiation passing through various water thicknesses, were observed. Al and H_2O capture γ-rays were prominent in these spectra. Relaxation lengths for the attenuation of γ-rays of different energies in water, were deduced. L. R. SHEPHERD

539.172.4 : 545.7

Analysis and safe disposal of gases from Los Alamos "water boiler" reactor. *See Abstr.* 8749

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

8661. Evidence supporting the existence of two types of heavy mesons giving a secondary μ meson. T. F. Hoang, L. Jauneau, G. Kayas, L. Leprince-Ringuet, D. Morellet, A. Orkin-Lecourtois and J. Trembley. *C.R. Acad. Sci.* [*Paris*], **238**, 1633–5 (*April* 21, 1954) *In French.*

A 10 000 μ heavy meson track decaying at rest into a 33 MeV μ, also coming to rest, was analysed by photometric, grain counting, gap counting and scattering methods to give a mass of $1170 \pm 54\ m_e$. Other K mesons gave the usual mass $890 \pm 40\ m_e$. W. J. SWIATECKI

539.18

8662. Phenomenology of the pion-nucleon *S* waves. H. P. Noyes and A. E. Woodruff. Letter in *Phys. Rev.*, **94**, 1401–2 (*June* 1, 1954).

Experimental evidence indicates that the two phase

shifts for isotopic spin $\frac{1}{2}$ and $\frac{3}{2}$ have the same sign near threshold. This behaviour is predicted by the S-wave potential of Marshak [Abstr. 1933 (1953)] and Woodruff (1953). P. T. MATTHEWS

539.18 : 537.591.1

8663. Theory of unstable heavy particles. H. Enatsu, H. Hasegawa and P. Y. Pac. *Phys. Rev.*, **95**, 263–70 (*July* 1, 1954).

In order to explain the nature of unstable heavy particles which are found in the penetrating components of cosmic rays, a possible model is presented. A mass relation for elementary particles is derived from the conditions for the elimination of divergences of the nucleon and heavy-nucleon self-energies. By choosing a suitable set of interactions, the lifetimes of these particles are calculated. Their production is evaluated, and their contribution to the magnetic moments of nucleons is also discussed. It is found that the predictions of the present theory are not qualitatively at variance with experimental results. A.

539.18

8664. The capture of a μ^- meson by a deuteron. A. Rudik. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 4, 739–42 (1953) *In Russian.* English translation, *National Sci. Found. NSF-tr*-219.

The capture probabilities are calculated by perturbation theory for scalar, vector, tensor, axial vector and ps. scalar couplings. Their ratios to the capture probabilities by a proton are $\sim 0{\cdot}75$ for a, t and ps and $\sim 0{\cdot}3$ for s and v. The corresponding ratios for capture by D to capture by He^3 and $\sim 0{\cdot}11$ and $\sim 0{\cdot}045$. W. J. SWIATECKI

539.18

8665. Decay of the χ meson. S. Sueoka. Letter in *Phys. Rev.*, **94**, 1398–9 (*June* 1, 1954).

The selection rules following from angular momentum, parity and extensions of Furry's theorem (assuming intermediate virtual nucleons) show that the τ-meson must be ps (pseudoscalar) or pv. If the neutral particle in the decay $\chi^{\pm} \rightarrow \pi^{\pm} + ?$ is a γ, then χ is v or pv; if it is a π^0, χ is s or v. On the latter assumption the χ-meson can, therefore, not be identified with the τ-meson. P. T. MATTHEWS

539.18

8666. Mean lives of positive and negative mu mesons. N. N. Biswas and M. S. Sinha. *Phys. Rev.*, **94**, 1400–1 (*June* 1, 1954).

The mean life of μ-mesons in Al, S, C and Pb has been determined using a delayed coincidence technique. The integral decay curves for Al and S show two distinct slopes because of the competing processes of nuclear capture and decay of negative mesons in these materials. The curves for C and Pb show a single slope only since in these materials the number of negatives decaying is negligible. Values are given for the mean lives of the positive and negative mesons and for the ratio of numbers of positives to negatives. H. ELLIOT

539.18

8667. Decay scheme of the τ meson. N. Baker and O. Bergmann. *Phys. Rev.*, **95**, 174–5 (*July* 1, 1954).

A statistical examination of the data at present available on τ-meson decay shows that it is consistent with a two-body decay scheme: $\tau \rightarrow \pi + X^0 \rightarrow \pi + \pi^+ + \pi^-$. The mass of the intermediate particle X^0 would have to be about $595m_e$ and the Q value for its decay about 22 MeV. A.

539.18

8668. Q value of Λ^0 decay. V. A. J. van Lint, G. H. Trilling, R. B. Leighton and C. D. Anderson. Letter in *Phys. Rev.*, **95**, 295–6 (*July* 1, 1954).

From photographs obtained in a 48 in. magnet cloud chamber, 19 events were selected as being easily consistent with the interpretation $\Lambda^0 \rightarrow p^+ + \pi^-$. Analysis of these gives for the energy release $(34{\cdot}7 \pm 1)$ MeV. J. S. BELL

539.18

8669. Interaction of π^+ mesons in photographic plates. II. A. Minguzzi, G. Puppi and A. Ranzi. Letter in *Nuovo Cimento*, **11**, 697–700 (*June*, 1954).

For Pt I, see Abstr. 4991 (1954). 488 events including stars and scatterings produced in plates exposed to a 62 MeV π-meson beam were examined. In 197 of these events a π-meson emerged and these events have been analysed in terms of the fractional energy loss $(\Delta E/E)$ of the π-meson. It is shown that two groups exist, an elastic group symmetrically distributed with respect to $\Delta E/E = 0$ and a broad inelastic group with practically any fractional energy loss. The interpretation of these data is briefly discussed. H. ELLIOT

539.18

8670. Pion production ratios. D. C. Peaslee. Letter in *Phys. Rev.*, **94**, 1085 (*May* 15, 1954).

Recent measurements which show a π^+/π^- production ratio $\rho = 6$ for 1 BeV p on Be^9 and $\rho = 1{\cdot}8$ at 2·3 BeV can be interpreted in terms of an excited nucleon state with isotopic spin $\frac{3}{2}$ (not $\frac{1}{2}$), the decrease in ρ being associated with the predominance at lower energies of processes where only one of the nucleons is excited. Analogous effects from a further $T = \frac{5}{2}$ excited state. W. J. SWIATECKI

539.18

8671. Angular distribution and yield of the process $p + d \rightarrow t + \pi^+$. W. J. Frank, K. C. Bandtel, R. Madey and B. J. Moyer. *Phys. Rev.*, **94**, 1716–21 (*June* 15, 1954).

The angular distribution of the process $p + d \rightarrow t + \pi^+$ has been determined for 340 MeV incident protons from the Berkeley 184 in. synchrocyclotron. The process was identified at one angle by a comparison of measured values with predicted values of the correlated angles, particle ranges and triton time of flight. During one continuous run differential cross-sections were measured at six pion centre-of-mass angles ranging from 30° to 150°, with the apparatus set for the predicted correlated angles, minimum ranges and triton time flight but without further tests of identification. The cross-section is constant at about 0·45 microbarn/steradian over pion centre-of-mass angles of 180° to 90°. The cross-section rises in the forward direction to a value around 5 microbarn/steradian at 0°. The total yield of the process is estimated by numerical integration to be 15 microbarn. A.

539.18

8672. Hard core interpretation of the reaction $p + d \rightarrow \pi^+ + t$. S. A. Bludman. *Phys. Rev.*, **94**, 1722–3 (*June* 15, 1954).

The cross-section for this reaction is calculated for

three Hulthén deuteron wave-functions. A hard core in the deuteron at one-half meson Compton wavelength reduces the total cross-section and flattens the angular distribution in the backward direction in agreement with experiment. A.

539.18

8673. Cloud-chamber observations of some unusual neutral V particles having light secondaries. V. A. J. VAN LINT, C. D. ANDERSON, E. W. COWAN, R. B. LEIGHTON AND C. M. YORK, JR. *Phys. Rev.*, **94**, 1732–5 (*June* 15, 1954).

From six cloud-chamber photographs of unusual V^0 decay events, the following conclusions are drawn: (1) there is a neutral V particle that decays into two particles lighter than κ-mesons with a Q value too small to be consistent with a $\theta^0(\pi, \pi, 214\ \text{MeV})$ particle; (2) some of these events cannot be explained in terms of the decay of a $\tau^0(\pi^0, \pi^-, \pi^+, Q \sim 80\ \text{MeV})$ particle; (3) these events can be explained by any one of a number of three-body decay schemes, but two different types of V particles must be postulated if two-body decays are assumed. A.

539.18 : 539.172.3

8674. Photoproduction of charged pi mesons from hydrogen and deuterium. T. L. JENKINS, D. LUCKEY, T. R. PALFREY AND R. R. WILSON. *Phys. Rev.*, **95**, 179–84 (*July* 1, 1954).

Photoproduction cross-sections of charged π-mesons from hydrogen and deuterium have been measured as a function of meson angle at γ-ray energies of 200, 235 and 265 MeV. The angular range extends from 30° to 180° in the laboratory system. Absolute cross-sections have been determined. A least-squares fit of the measured cross-sections has been made to the expression $A + B\cos\theta + C\sin^2\theta$, which assumes only S- and P-wave scattering. The coefficients so determined are qualitatively consistent with electric and magnetic dipole absorption together with the assumption of a resonant state of angular momentum $\frac{3}{2}$ and of energy close to 300 MeV. Comparison with neutral meson production indicates some direct charged meson production in the P state. A.

539.18

8675. Cloud-chamber study of charged V particles. C. M. YORK, JR, R. B. LEIGHTON AND F. K. BJØRNERUD. *Phys. Rev.*, **95**, 159–70 (*July* 1, 1954).

An analysis of 103 charged V-particle decays is presented. These events have been observed with a double cloud chamber operated at 1750-m altitude. The events in the upper chamber appear to have markedly different properties from those in the lower. The particles in the upper chamber have measured properties which are in every respect consistent with those of the κ-meson. Their lifetime is in the range 5×10^{-10} to 2×10^{-8} sec; their mass is $\sim1000m_e$; their transverse momentum distribution is consistent with a three-body decay scheme; the momentum in the centre-of-mass system of their charged decay products is also consistent with three-body decay; and their frequency of production is greater than 0·4% of the total number of shower particles observed. On the other hand, the particles observed in the lower chamber have a lifetime in the range 10^{-11} to 3×10^{-10} sec; their transverse momentum distribution is consistent with a two-body decay scheme; their frequency of production is greater than 0·8% of the total number of shower particles; they are observed with approximately one-third of the frequency of Λ^0 particles; and they apparently can be produced in meson-nucleon collisions. The majority of the particles in the lower chamber are tentatively identified as charged hyperons with the aid of two cases which appear to have proton secondaries. The proposed decay scheme is $V_1^+ \rightarrow p + \pi^0 + Q$; and in order to fit all of the data, the alternate mode of decay, $V_1^+ \rightarrow \pi^+ + n + Q$ must be introduced. The Q value is estimated to be 125 MeV. A.

539.18

8676. Some general relations between the photoproduction and scattering of π mesons. K. M. WATSON. *Phys. Rev.*, **95**, 228–36 (*July* 1, 1954).

With a partial wave analysis of the photomeson cross-sections are combined the principle of charge independence, the hypothesis of time reversibility and the unitarity of the scattering matrix. This leads to a natural starting point for the study of the photo cross-sections. It also leads to some close relations between the photoproduction and scattering of pions in that the complex phases of the matrix elements for photoproduction are explicitly given in terms of the scattering phase shifts. One consequence of this is that there must be an S-wave contribution to the π^0 photoproduction on whose amplitude a lower limit can be given in terms of the S-wave pion-nucleon scattering. A second, independent lower limit on the S-wave term for the π^0 cross-sections can be expressed in terms of the π^-/π^+ ratio. Several other non-trivial conditions are imposed on the cross-sections. A.

539.18

8677. The anomalous scattering of μ mesons. D. A. TIDMAN. Note on *Proc. Phys. Soc.* [*London*] *A*, **67**, 559–61 (*June*, 1954).

Contributions arising from assumed anomalous magnetic moments of the μ-meson and nucleons are evaluated in Born approximation, but are found to be too small to explain the anomalous scattering.

G. E. BROWN

539.185

8678. Polarization of nucleons elastically scattered from nuclei. G. A. SNOW, R. M. STERNHEIMER AND C. N. YANG. Letter in *Phys. Rev.*, **94**, 1073–4 (*May* 15, 1954).

Polarizations P calculated as function of angle up to 30° by the WKB method for 316 MeV neutrons scattered by a spherical well of depth 13 MeV in which the inverse mean free path is $1\cdot7\times10^{12}\ \text{cm}^{-1}$ and there is an l-s coupling term of the type $\delta(r\text{-}R)(l\text{-}s)$ or $(R/r)^2(l\text{-}s)$. There are peaks at 10–15° and around 25° where P goes up to ~100%.

W. J. SWIATECKI

539.185 : 530.145

8679. Correlations in space and time and Born approximation scattering in systems of interacting particles. L. VAN HOVE. *Phys. Rev.*, **95**, 249–62 (*July* 1, 1954).

A natural time-dependent generalization is given for the well-known pair distribution function $g(\mathbf{r})$ of systems of interacting particles. The pair distribution

in space and time thus defined, denoted by $G(\mathbf{r}, t)$, gives rise to a very simple and entirely general expression for the angular and energy distribution of Born approximation scattering by the system. This expression is the natural extension of the familiar Zernike–Prins formula to scattering in which the energy transfers are not negligible compared to the energy of the scattered particle. It is therefore of particular interest for scattering of slow neutrons by general systems of interacting particles: G is then the proper function in terms of which to analyse the scattering data. After defining the G function and expressing the Born approximation scattering formula in terms of it, the paper studies its general properties and indicates its rôle for neutron scattering. The qualitative behaviour of G for liquids and dense gases is then described and the long-range part exhibited by the function near the critical point is calculated. The explicit expression of G for crystals and for ideal quantum gases is briefly derived and discussed. A.

539.185 : 539.166.74

8680. Point source kernel for diffusion with small-angle scattering. W. E. Drummond and C. S. Gardner. *Phys. Rev.*, **94**, 1491–6 (*June* 15, 1954).

Analytical expressions are derived for the particle flux from a point source which emits particles with an angular distribution $(1/\pi\beta)\exp[-\theta^2/\beta]$. The emission is into an infinite medium characterized by a strongly forward differential scattering cross-section which can be approximated by a Gaussian $\Sigma(\theta) = (\Sigma/\pi\alpha)\exp[-\theta^2/\alpha]$, and in which all cross-sections are energy-independent. In particular, an asymptotic expression is obtained for large Σr, viz.

$$\phi(r,\theta) \simeq \frac{\exp[-(\Sigma_t - \Sigma)r]}{\pi r^2(\beta + \frac{1}{3}\alpha\Sigma r)} \exp\left\{-\frac{\theta^2}{\beta + \frac{1}{3}\alpha\Sigma r}\right\}$$

A.

539.185 : 548.7

Effects of neutron irradiation on quartz oscillators. *See Abstr.* 8771

539.185.08

8681. A fast neutron spectrometer. J. R. Holt and A. E. Litherland. *Rev. sci. Instrum.*, **25**, 298 (*March*, 1954).

Recoil protons from a 10 mg/cm^2 polyethylene radiator are detected by electron collection in a 400 lb/in.^{2} argon filled triple ion chamber, the geometry ensuring adequate resolution in the range 5–25 MeV. A coincidence pulse from the first two ion chambers, which are close together near the radiator, serves to initiate the time base of an oscilloscope which receives its y deflection from electrons drifting across a uniform field region towards a final collector. The leading edge of each of these pulses therefore appears after a time interval proportional to (E_0—energy of the recoil protons) when E_0 is a constant of the spectrometer. From the known geometry of the spectrometer the energy of the incoming neutron is thus computed. D. R. Chick

539.185.08

8682. Fast-neutron dosimetry in a small tissue-equivalent phantom. W. A. Mills and G. S. Hurst. *Nucleonics*, **12**, 17–19 (*April*, 1954).

Dose rates at different depths inside a wet-tissue-equivalent phantom were measured by means of a homogeneous proportional counter (polyethylene walls and ethylene filling) and compared with the dose rates measured in air with the same counter, at corresponding distances from the neutron source. The phantom consisted of an aqueous solution of sucrose and urea in an aluminium tank $15 \times 15 \times 28$ cm. Build up factors of 1·20 and 1·33 and relaxation lengths of 10·0 and 11·3 cm were determined respectively for the neutrons from Po–B and Po–Be sources. L. R. Shepherd

539.185.08

8683. Time of flight of 14·1-MeV neutrons. A. Ward. Letter in *Nature* [*London*] **173**, 771–2 (*April* 24, 1954).

Describes a technique combining good resolution and detection efficiency. J. M. Cassels

539.185.08

8684. On the theory of probe distortions in a neutron field. M. A. Vigon and K. Wirtz. *Z. Naturforsch.*, **9a**, 286–91 (*April*, 1954) *In German.*

Expressions for the distortions in the neutron density produced by spherical and disk-like probes are derived assuming elementary diffusion theory and the absence of density gradients in the undisturbed state. Corrections to the activation of radioactive probes are deduced. W. J. Swiatecki

539.185.08

8685. Absolute measurement of the Union Minière neutron standard. A. De Troyer and G. C. Tavernier. *Bull. Acad. Roy. Belgique Cl. Sci.*, **40**, *No.* 2, 150–66 (1954).

The source was immersed in water and the spatial distribution of the moderated neutrons was studied with gold foils. Absolute values for the absorption cross-sections of hydrogen and gold were taken from the literature. Good agreement with other recent work was found. J. M. Cassels

539.185.08

8686. A fast neutron-scintillation spectrometer. J. E. Draper. *Rev. sci. Instrum.*, **25**, 558–62 (*June*, 1954).

A spectrometer employing two organic crystals in coincidence has been investigated experimentally. Considerations are made of some factors involved in the efficiency, resolution, neutron-energy range and background effects. The rôle of the carbon in the scintillation crystal is considered not to be important except in its increase of the plural scattering in the analysing crystal. The D(d, n), T(d, n) and Li(d, n) spectra as taken with this instrument are presented.

A.

539.185.08 : 537.542

8687. A stereoscopic reprojection apparatus for neutron scattering experiments. M. H. Alston, A. V. Crewe and W. H. Evans. *J. sci. Instrum.*, **31**, 252–4 (*July*, 1954).

A cloud-chamber reprojection system is described which has been used in neutron scattering experiments with a point source of neutrons 20 in. away from the chamber. Scattering angles and ranges of recoil particles are measured directly. A.

539.185.08 : 537.542

Fast neutron scintillation survey meter. *See Abstr.* 8372

539.185.7 : 537.533.75 : 537.534.75 : 530.162
Application of Markov's method to sequences of energy losses. *See Abstr.* 8073

STRUCTURE OF SOLIDS 539.2

539.211
8688. The time effect in the fracture of glass from the standpoint of nucleation theory. T. YOKOBORI. *J. chem. Phys.*, **22**, 951–2 (*May*, 1954).

Suggests that the delay time to fracture glass should be considered as determined by either chemical attack for long delays or an activation process occurring in the region where the stress is concentrated by a Griffiths crack. The latter mechanism leads to a three-parameter expression which fits observations for delay times 0·01 to 10 sec. At longer times the decay of strength is greater than calculated, indicating atmospheric attack. W. M. LOMER

539.213
8689. On the agglomeration of amorphous bodies. YA. E. GEGUZIN. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 1, 45–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-180.

Measurements were made of the initial diameter (a_0) of a glass capillary and of its diameter (a_t) at time t after its spontaneous decrease of bore at the softening temperature. The viscosity of the glass was then deduced from $\eta = (\sigma t)/(a_0 - a_t)$ where σ is the coeff. of surface tension taken as 300 erg/cm^2 and independent of temp. This was done at various temperatures and log η was plotted against 1/temp., from which the activation energy of viscous glass was deduced. The volume shrinkage of amorphous glass was deduced from the measurements of the change of bore of the capillaries and, when plotted against time, good agreement was found with the experimental results of Ivensen. A. C. WHIFFIN

539.215.4
8690. Errors in particle-size determination from settled suspensions. J. MCK. ELLISON. Letter in *Nature* [*London*] **173**, 948 (*May* 15, 1954).

Experiments show that it appears to be incorrect to assume that particles settled on a microscope slide are randomly orientated. Silica dust was measured in this way and also by suspending it in agar jelly and significant differences were found between the measured size distribution. J. M. HOUGH

539.217
8691. Diffusion of plasticizers in polyvinylchloride. W. KNAPPE. *Z. angew. Phys.*, **6**, *No.* 3, 97–101 (1954) *In German.*

Measurement of the variation of refractive index is used to follow the equalization of concentration of a plasticizer between two specimens of PVC pressed together and initially having concentrations of plasticizer differing by 20%. For plasticizer concentrations above 30% the results are given in terms of a (constant) mean diffusion coeff. Below 30% the diffusion coeff. is strongly dependent on concentration. The values of the coeff. range from 10^{-6} to 10^{-12} cm^2 sec^{-1} and from their variation with temp. the activation energies of diffusion are found to lie between 6 and 30 kcal per mole, the higher energy values being associated with the lower concentrations. The variation of electrical conductivity with concentration of plasticizer runs parallel to that of the variation of the diffusion coeff. The plasticizers used were tricresyl- and trioctyl-phosphates and dibutyl- and dioctyl-phthalates. W. GOOD

539.217
8692. On the role of alkaline halides in the diffusion of copper into the crystalline network of zinc sulphide. M. BANCIE-GRILLOT. *C.R. Acad. Sci.* [*Paris*] **238**, 1216–18 (*March* 15, 1954) *In French.*

The observed emission spectra of zinc sulphide, in the range 4000–6000 Å, containing $3·8 \times 10^{-5}$ g-ion Cl per mole ZnS and concentrations of $7·5 - 21·0 \times 10^{-5}$ g-ion Cu per mole ZnS, are discussed. The results are not compatible with the theory of compensation of charge [Abstr. 3157 (1953)].

G. I. W. LLEWELYN

539.217
8693. The diffusion of nitrogen in alpha iron. W. R. THOMAS AND G. M. LEAK. Letter in *Phil. Mag.*, **45**, 656–9 (*June*, 1954).

This was determined from measurements as a function of temperature of the internal friction caused by the presence of N_2 in solution [Abstr. 1681 (1948)]. $D = 3·1 \times 10^{-3} \exp(-18\,000/RT)$ cm^2/sec.

A. D. LE CLAIRE

539.217 : 532.7 : 533.15
Diffusion coefficient, solubility, and permeability for helium in glass. *See Abstr.* 8093

539.217 : 537.311.33
Diffusion of impurities in germanium. *See Abstr.* 8287

539.217.5
8694. Rare gas permeation through polymers. F. J. NORTON. Letter in *J. chem. Phys.*, **22**, 1145 (*June*, 1954).

Xenon has a faster steady-state rate of permeation through Neoprene and natural rubber than helium. It is suggested that of the two factors controlling permeation, viz. solubility of the gas and internal diffusion, the former is predominant for xenon.

W. GOOD

539.234 : 539.4.014.13
8695. The cause of stress in evaporated metal films. R. W. HOFFMAN, R. D. DANIELS AND E. C. CRITTENDEN, JR. Letter in *Proc. Phys. Soc.* [*London*] *B*, **67**, 497–500 (*June*, 1954).

The behaviour on annealing of the stresses in Ni films [Abstr. 3724 (1953)] is inconsistent with the origin of the stresses suggested by Murbach and Wilman [Abstr. 803 (1954)]. A. D. LE CLAIRE

539.26
8696. Changes in the lattice parameter of polycrystalline solid solutions and intercrystalline internal adsorption. V. I. ARKHAROV AND N. N. SKORNYAKOV. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 5, 841–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-96.

X-ray measurements on solid solutions of various elements (Sb, Be, Fe) in Cu showed changes in their

lattice parameter with changes in grain size which are reversible and are interpreted as due to an adsorption of solute at the grain boundaries. When two or more solutes are present one may be adsorbed to the comparative exclusion of the other, even though when present alone each is adsorbed. From the known dependence of the lattice parameter on concentration and from the present measurements, the width of the transition zone at the grain boundary was estimated to be 350–900 Å, assuming the concentration of material there to be equal to its maximum solubility in bulk Cu. A. D. LE CLAIRE

539.26

8697. On local distortions of the crystal lattices of alloys during transformation hardening. L. Moroz and T. Mingin. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 2, 249–51 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-99.*

The ratios of the integrated intensities of the (220) and (110) lines were measured in X-ray photographs of quenched, of annealed and of plastically deformed iron alloy (Fe + 4·3% Mn + 0·97% Cr). Although the quenched and the deformed alloy were of roughly equal hardness, the ratio $I(110)/I(220)$ was larger than for the annealed alloy by 7·7% for the quenched but by 32% for the deformed alloy. The difference in the nature of the lattice distortions in quenched and in deformed alloys which these results indicate is very briefly discussed. A. D. LE CLAIRE

539.26

8698. The study of sub-microscopic objects from the weakening of an X-ray beam. V. M. Genkin. *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 224–7 (1954) *In Russian.*

Using the formula for the intensity of scattered radiation it is possible to determine from the photometer curves of films of the direct and scattered X-ray beams the dimensions and number of sub-microscopic objects in a substance. The formula is strictly only applicable to very fine beams and infinitesimal photometer apertures but corrections are calculated.

A. L. MACKAY

539.26 : 539.213

8699. Structure of glassy B_2O_3. H. Richter, G. Breitling and F. Herre. *Z. Naturforsch.*, **9a**, 390–402 (*May*, 1954) *In German.*

Thin sheets of glassy B_2O_3 were examined by X-ray diffraction, using Cu $K\alpha$ and Mo $K\alpha$ radiation. Radial distribution curves are obtained by Fourier analysis and it is found that many sharp maxima exist up to interatomic distances of about 10 Å. From a comparison of the results with the known crystal structure of B_2O_3 it is concluded that the structure of the glassy state is based on B_2O_3 tetrahedra which are arranged in layers, regularly ordered over considerable distances. J. THEWLIS

539.26 : 539.215

8700. The determination of grain size from spotty X-ray diffraction rings. P. B. Hirsch. *Brit. J. appl. Phys.*, **5**, 257–60 (*July*, 1954).

A study is made of the effects of a distribution of grain size, a large absorption coefficient and overlapping diffraction lines on the values of grain size obtained from the number of spots on X-ray back reflection photographs from polycrystalline material. It is shown that accurate values of the mean grain size can be obtained by extrapolation to high exposure ratios and that the general "volume" formula relating the number of spots to the penetration of the beam into the specimen is applicable also in cases in which the average penetration of the beam is small compared with the grain diameter. A.

539.27

8701. On the contamination of samples in the electronic probe microanalyser. R. Castaing and J. Descamps. *C.R. Acad. Sci.* [*Paris*] **238**, 1506–8 (*April* 5, 1954) *In French.*

Metal samples bombarded in vacuum by a beam of electrons become covered with a layer of contamination due to the polymerization by the electrons of organic matter adsorbed on the surface. Various aspects of the contamination process are described and tentative explanations given of the phenomena observed. The rate of contamination can be considerably reduced by sweeping the surface of the sample during the bombardment with a stream of gas at low pressure. A. D. LE CLAIRE

539.27

8702. Note on the faithfulness of reproduction by replicas. H. Kimmel. *Naturwissenschaften*, **41**, *No.* 8, 186–7 (1954) *In German.*

A brief note on the validity and truthfulness of the reproduction in the preparation of collodion replicas. The shrinkage contractions are discussed and a brief discussion is given of the thickness alternation on changing from a thin liquid film to a thin solid film, measurement being made by multiple-beam interferometry and the electron microscope. S. TOLANSKY

539.27

8703. High resolution replicas and their application. T. Hibi and K. Yada. *J. appl. Phys.*, **25**, 712–19 (*June*, 1954).

Using methyl methacrylate as an intermediate replica, an attempt was made at a high-resolution two-step one, by improving evaporation elements and evaporation method. It was found that, by using Zr, Si and Fe, with Ge and Cr as evaporation elements, the resolution of two-step replicas was superior to that obtained up to the present. It is also known that the resolution of replicas obtained by performing metallic evaporation after treatment by ion or electron bombardment for a methyl methacrylate intermediate replica is superior to that without bombardment. Two evaporation methods—the usual continuous method and an intermittent one—were compared. A new method for the production of surface replicas of micro-specimens is also proposed. The high-resolution replica obtained here is compared with others along with a brief consideration of the results obtained. A.

539.27

8704. The origin of several fine structures in very thin single-crystal lamellae. R. Bernard and E. Pernoux. *Optik*, **11**, *No.* 7, 335–48 (1954) *In German.*

The authors describe further work with the electron microscope to identify certain fine structures which appear in images of molybdenum oxide crystals

[Abstr. 5132 (1953)]. The work has been continued using a schlieren-method, similar to that of Rang and Mollenstedt. The formation of interference bands by two neighbouring crystals is discussed, and the results compared with those of other authors.

A.E.I. RESEARCH LABORATORY

539.27

8705. Shadowing technique for electron microscopy —a possible substitute for the high-vacuum evaporation technique. A. E. BILLS AND R. LEFKER. *J. appl. Phys.*, **25**, 901–3 (*July*, 1954).

The method, which uses thallium chloride immersed in distilled water as the shadowing material, is much less time consuming than is the usual method that involves high-vacuum metal evaporation; the results obtained are not of the same high quality as those of the usual method, but the time saving often justifies the method. Polystyrene Latex (batch No. 580) is introduced on the specimen screen, to provide an internal calibration standard; this standard makes it possible to measure the angle of shadowing. A.

539.27 : 541.1

The study of chemical reactions by electron diffraction. *See Abstr.* 8725

539.27 : 541 15

8706. Decompositions of inorganic specimens during observation in the electron microscope. R. B. FISCHER. *J. appl. Phys.*, **25**, 894–6 (*July*, 1954).

Several inorganic substances have been examined by electron microscope and selected area electron diffraction techniques. Large crystals of sodium chloride and potassium chloride break up into many smaller crystals of the same substances. Ammonium chloride evaporates, and nitron nitrate appears merely to melt. Reduction to metal was found for silver chloride, silver nitrate, lead carbonate and cupric oxide. Only morphological changes were observed on bombardment of silver sulphate, lead oxide, lead chloride and gold chloride. Hydrous ferric oxide and aluminium oxide were converted to crystalline forms which could not be identified by electron diffraction. A.

539.27 : 548.5

8707. Electron microscope observation of NaCl surfaces after treatment with a habit-changing substance. H. WESTPHAL. *Z. Phys.*, **137**, *No.* 1, 61–6 (1954) *In German.*

This investigation carries on the work of Raether on the action of heat or water on the fine structure of polished surfaces of rock salt [*Optik*, **1**, 296, 1946]. If a saturated solution of NaCl is dried slowly on such a surface, in a regulated stream of dry air, regular growth of the original structure is obtained. Addition of 5% urea causes growth of octahedral faces at the cube corners. On 111 faces truncated pyramids initially exist, and these grow into sharp points from pure NaCl solution. In presence of urea, on the other hand, lateral growth occurs until the gaps between pyramids are filled and a smooth continuous surface results, as expected on the theories of Kossel and Stranski on crystal growth. Silicon monoxide replicas were employed to follow the stages of growth, electron micrographs at 1000× to 4000× being reproduced. V. E. COSSLETT

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31

8708. On the after-effect theory of elastic relaxation. J. MEIXNER. *Z. angew. Phys.*, **6**, *No.* 5, 215–17 (1954) *In German.*

An after-effect function $Q_{ik}(t)$ is introduced so that the stress at time t is given by $\sigma_i(t) = c_{ik}\varepsilon_k(t) + \int_0^\infty Q_{ik}(tl)\varepsilon_k(t-u)du$. It is shown that for an isotropic body only two functions Q, for hydrostatic and shear stress, are necessary. It is shown how further functions may be introduced to deal with temperature variations and the specific entropy of a solid, and the treatment is extended to cubic crystals. The Onsager reciprocal relations naturally arise from this treatment.

W. M. LOMER

539.32

8709. An instrument for testing high polymers at [audio-] frequencies. G. K. DEMISHEV. *Zh. tekh. Fiz.*, **24**, *No.* 2, 299–307 (1954) *In Russian.*

The impedance of a voice coil mounted in a magnetic field and symmetrically loaded with two equal specimens of the resin to be tested is measured in a Wheatstone bridge at frequencies of 20 to 500 c/s under controlled oscillation amplitudes (10^{-5} to 10^{-2} cm) and temperatures (e.g. −180°C or +200°C). Formulae are derived for calculating the shear modulus and the tangent of the angle of mechanical loss from the coil impedance data. A. GELBTUCH

539.32 : 534.213

8710. A dynamic method for measuring the expansion coefficient and the temperature coefficient of the modulus of elasticity. K. MÍŠEK. Letter in *Czech. J. Phys.*, **3**, 169–70 (*June*, 1953) *In Russian.*

Both coefficients are determined simultaneously from the measured frequencies of longitudinal or lateral waves in the substance at three temperatures, preferably within an interval of less than 100°C.

A. GELBTUCH

539.32 : 534.22

Velocity of elastic waves in the solidified inert gases. *See Abstr.* 8106

539.32 : 539.67 : 536.424

8711. Moduli and internal friction of magnetite as affected by the low-temperature transformation. M. E. FINE AND N. T. KENNEY. *Phys. Rev.*, **94**, 1573–6 (*June* 15, 1954).

The low-temperature ordering transformation in magnetite is the source of large non-elastic effects. For example, Young's modulus for the (111) direction at 108°K is 30% lower than the value one would estimate from higher-temperature measurements; an internal friction peak occurs near 95°K. The non-elastic effects are attributed to stress-induced ordering of Fe^{++} and Fe^{+++} among the octahedral sites in the lattice. A.

539.32.08 : 621.376.33 : 621.317.39

8712. An improved method of measuring dynamic elastic constants, using electrostatic drive and frequency-modulation detection. H. PURSEY AND E. C. PYATT. *J. sci. Instrum.*, **31**, 248–50 (*July*, 1954).

Apparatus is described for the measurement of the natural longitudinal resonant frequencies of metal bar

specimens. The specimen is driven by the application of an alternating electrostatic force between one end and a small fixed plate parallel to it. The resonance is detected by a frequency-modulation system, working at 60 Mc/s, using the same plate as for the drive. The specimen mounting and drive arrangements are described and details given of the frequency-modulation and detection circuits. The equipment has a considerably wider frequency range than previous designs and measurements can be made, both of the fundamental resonant frequency, and of the frequencies of a series of higher modes of vibration, on specimens of widely differing sizes. These observations, when corrected for small degrees of anisotropy, enable the values of the true isotropic moduli to be derived to an accuracy of one or two parts in 10^3.

A.

539.37

8713. Jumplike deformation in the linear "elastic" range of the strain diagram. N. F. SYUTKIN. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 1, 83–5 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-74.*

This was observed with wires ($\sim$ 2 mm dia.) of an ageing Zn + 20% Al alloy. The first of the jumps (sudden increases in stress at constant strain rate) occurs almost at the beginning of the linear range, i.e. well below "elastic" limit, at a stress which (1) at low temperatures (0–150°C) is larger the higher the strain rate, (2) is independent of strain rate at high temperatures ($>$ 200°C), (3) for a given strain rate decreases with increase in temperature, reaching a minimum at 250°C. The average difference of stresses between successive jumps is larger than the stress for the first jump and increases with increasing strain rate. A brief discussion of the effect is given relating it to the internal stresses around precipitating particles of the new phase. A. D. LE CLAIRE

539.374

8714. On the effect of change in deformation rate on plastic deformation. L. I. VASIL'EV, A. S. BYLINA AND M. P. ZAGREBENNIKOVA. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 5, 767–9 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-138.*

The rates of strain of wires of Cu and of Sn were altered suddenly during the straining. For Cu a change in rate (0·033%/min to 27%/min or vice versa) at small degrees of strain ($\log l/l_0 \sim 0{\cdot}05$) produces in the stress-strain curve a gradual transition to and ultimate coincidence with the curve obtained for samples which are strained only at the new rate. The transition does not occur when the change is made at larger strains ($\log l/l_0 \sim 0{\cdot}2$). With Sn the effect is less noticeable. The results are discussed in terms of dislocations of various degrees of stability.

A. D. LE CLAIRE

539.374

8715. On the mechanism of plastic deformation. G. LEIBFRIED AND P. HAASEN. *Z. Phys.*, **137**, *No.* 1, 67–88 (1954) *In German.*

The processes of plastic deformation are discussed in terms of the dislocation picture. No high-velocity motion of dislocations is considered. The basic structure of the crystal is described in terms of the dislocations intersecting the slip planes. The growth of fine slip is described in terms of this structure and of interactions during deformation. Coarse slip is produced by a co-operation, in the later stages, of the fine slip sources. Differences between the work-hardening curves for cubic and close-packed hexagonal metals are explained in terms of these concepts, and it is concluded that in a cubic metal the final state is typically an array of edge dislocations, while in the h.c.p. it is typically of screw dislocations.

W. M. LOMER

539.374 : 548.0

8716. A new mechanism of plastic deformation of crystals. I. The study of the process of "small layer formation" [plastinkovanie] by an optical method. A. V. STEPANOV AND A. V. DONSKOĬ. *Zh. tekh. Fiz.*, **24**, *No.* 2, 161–71 (1954) *In Russian.*

Two well-known mechanisms, slip and twinning, account for the plastic deformation of crystals by external mechanical force. A third new mechanism is described and is termed *plastinkovanie* [literally, "small layer formation"]. Experimental details of this effect in a square section bar of rock salt subjected to tension along the axis [110] at a temperature of about 200°C are given. Groups of almost parallel layers inclined at an angle to the axis are formed.

W. BARDSLEY

539.374 : 548.0

8717. A new mechanism of plastic deformation of crystals. II. Determination crystallographically of the characteristic process of "small layer formation" [plastinkovanie]. A. V. STEPANOV AND A. V. DONSKOĬ. *Zh. tekh. Fiz.*, **24**, *No.* 2, 172–83 (1954) *In Russian.*

Discusses the subject [see preceding abstract] as a possible basis for studying grain deformation in polycrystals, textures and residual strains. Also its occurrence in other materials and its influence on the mechanical properties of crystals and upon recrystallization processes. W. BARDSLEY

539.374 : 548.7

8718. Lattice imperfections and plastic deformation in metals. I. Nature and characteristics of lattice imperfections, notably dislocations. H. G. VAN BUEREN. *Philips tech. Rev.*, **15**, 246–57 (*Feb.–March*, 1954).

The theoretical necessity for the existence of lattice imperfections in crystals, such as vacancies, interstitial atoms and dislocations, is clarified in the light of a number of phenomena related to the plastic deformation of metals, e.g. the occurrence of slip lines, work hardening and variations in the electrical conductivity. This article is devoted mainly to a discussion of the more important characteristics of dislocations, and deals successively with the geometrical aspects of various kinds of dislocation, their behaviour under shear stresses in the crystal as illustrated by means of a model, and the movement of dislocations, taking into account the difference between conservative and non-conservative movements. Lastly, the formation of lattice defects of different kinds as the outcome of interaction between existing defects is examined. A.

539.374 : 548.7

Effect of plastic flow upon color centers in alkali halide crystals. *See Abstr.* 8779

539.4.016.2 : 537.312.9

8719. Change of the resistivity of some face centered cubic metals after cold-working at liquid air temperature. J. A. MANINTVELD. *Delft: Technische Hogeschool* (1954) 82 *pp.*

A detailed account is given of experimental measurements of the increase $\Delta\rho$ in resistivity ρ of Cu, Ag and Au wires after cold working, and of the subsequent recovery of part of this on annealing for various times at various temperatures. $\Delta\rho/\rho$ is a few per cent for wires stretched a few per cent; much larger changes occur in wires that have been rolled, e.g. 200% for an 8% reduction in area. The initial recovery of $\Delta\rho$, that which occurs without change in hardness, takes place in two successive steps, e.g. for Cu, the first in the temperature range -140 to -70°c and the second in the range -30 to $+40$°c. With each recovery step is associated a single and constant activation energy Q, that for the first being appreciably smaller than that for the second, e.g. for Ag 0·18 and 0·69 eV respectively. Q is roughly independent of the type and extent of the deformation, but the rate of recovery is greater after rolling than after stretching. A long discussion of the origin of the effects observed leads to the conclusion that the resistance increase is due to the creation of vacancies, interstitials and dislocations by the cold work, and that the first recovery step is due to the diffusion of interstitials and the second to diffusion of vacancies to places in the lattice (mosaic boundaries, dislocations, etc.) where their effect on the resistance is diminished. The remaining resistance increase is attributed to the dislocations. Experiments by others on the measurement and release of energy stored after cold work and on the effect on ρ of cold working, of quenching and of irradiation with high-energy particles, are reviewed and the conclusions to be drawn from them pertinent to the present work shown not to be at variance with it. A. D. LE CLAIRE

539.6

8720. Theory of formation and breakdown of welding bridges between the friction surfaces. M. P. LEVITSKIĬ. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 4, 797–8 (1953) *In Russian.*

Analyses the process of bringing together the atomic lattices of the solid surfaces A and B which are in the state of mutual friction as a reaction given by the equation $(A+B)_2 \rightleftharpoons AB^{++} \rightleftharpoons (A+B)_1$, where $(A+B)_1$ are atoms of surface A and B, which produce the lattice of the pseudo-stable phase before the free-energy barrier ΔF^{++} has been reached and form the easily deformable portion of the welding bridge; $(A+B)_2$ are atoms of the same surfaces, which have come sufficiently near to each other to form a common lattice of the strong crystalline portion of the bridge. while AB^{++} are atoms forming an active complex. F. LACHMAN

539.61

8721. Investigation of the interrelations between frictional and adhesive forces by the method of crossed fibres. B. V. DERYAGIN, S. B. RATNER AND M. F. FUTRAN. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 6, 1137–40 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-228.*

On the theory of Deryagin [*Dokl. Akad. Nauk SSSR*, **3**, 93 (1934)], frictional force has two components, one depending on the load (N) and the other on the adhesive force between surfaces (N_0). Experiments with crossed quartz fibres designed to obtain direct measurements of second component. Authors find for $N > 0$ the unexpected result that friction force depends on load in accordance with Deryagin's theory. For $N < 0$, a friction force independent of load and contact is maintained between fibres for values of N down to $-N_0$. Tangential adhesion and friction are equal at zero load. These effects cannot yet be explained. J. W. MENTER

539.63

8722. An effect produced by oblique impact of a cylinder on a thin target. W. A. ALLEN, J. M. MAPES AND W. G. WILSON. Letter in *J. appl. Phys.*, **25**, 675–6 (*May*, 1954).

When cylindrical steel projectiles strike lead targets at angles less than a certain critical angle there is negligible plastic flow, above this angle the front of the cylinder is marked by a series of ridges. The critical angle is thought to be the same as that found under other conditions [Abstr. 2994 (1953)]. T. C. TOYE

539.893

8723. Compression to 10 000 atmos. of solid hydrogen and deuterium at 4·2°K. J. W. STEWART AND C. A. SWENSON. Letter in *Phys. Rev.*, **94**, 1069–70 (*May* 15, 1954).

For both substances the volume fits the expression $p = 3/2K[(V_0/V)^{7/3} - (V_0/V)^{5/3}][1 - a(V_0/V)^{2/3} + a]$. For hydrogen $K = 1990$ atm, $a = -1{\cdot}9$; for deuterium $K = 3180$ atm, $a = -1{\cdot}6$. It was found that solid hydrogen is highly plastic at 4·2°K and a Bridgman seal had to be used to prevent extrusion. R. O. DAVIES

539.893

8724. Certain effects of pressure on seven rare earth metals. P. W. BRIDGMAN. *Proc. Amer. Acad. Arts Sci.*, **83**, *No.* 1, 1–22 (1954).

Extension of earlier measurements [Abstr. 3478 (1948), 837 (1953), 1340 (1954)] to samarium, dysprosium, holmium, erbium, thulium, ytterbium, lutecium. The properties studied (at room temperature) were: the volume compression up to 40 000 kg/cm^2; the electrical resistance to 30 000 kg/cm^2 under truly hydrostatic pressure, and to 100 000 under a stress only approximately hydrostatic; and the plastic shearing strength as a function of pressure up to 100 000. The atmospheric densities, specific resistance and temperature coefficient of resistance between room temperature and 0°c were also determined, and, for ytterbium only, the electrical resistance was measured up to 200°, but only to 7000 kg/cm^2 at the higher temperatures. All the metals except samarium show anomalies, but the anomalies are all minor except for ytterbium. For this metal, the atmospheric density, melting point and mechanical softness are much lower than those of its neighbours; under pressure the compressibility is three times too high, and the electrical resistance is highly anomalous, at first increasing rapidly and at an accelerated rate to near 50 000 kg/cm^2, where there is a rapid collapse by a factor of the order of 16 to about three-quarters the initial value. E. H. SONDHEIMER

PHYSICAL CHEMISTRY 541

541.1 : 539.27

8725. The study of chemical reactions by electron diffraction. J.-J. TRILLAT. *Cahiers de Phys., No.* 49, 44–60 (1954) *In French.*

A survey of the methods and advantages of using electron diffraction to study chemical reactions is given. Examples include the study of metallic oxidation, adsorption of organic materials on metals, chemical transformations on electron bombardment, properties of freshly-cleaned surfaces, and inter-diffusion of metals to form alloys. A recently developed method of continuously recording changes in the diffraction pattern promises to have wide application to these and similar studies.

A.E.I. RESEARCH LABORATORY

PHASE EQUILIBRIUM. CHEMICAL REACTIONS 541.11/.12

541.121 : 536.7

8726. Stationary states of chemical systems and the reciprocal relations of Gibert. A. PÉNELOUX. *C.R. Acad. Sci.* [*Paris*] **238,** 794–6 (*Feb.* 15, 1954) *In French.*

In order to apply the Onsager reciprocal relations to chemical phenomena it is necessary to postulate a linear dependence of reaction velocities upon the affinities, which can be deduced rigorously only when all affinities are nearly zero. The Gibert reciprocal relations enable one to apply the thermodynamics of irreversible processes to chemical systems which are not thus restricted. Closed chemical systems may have stationary states other than that of equilibrium; the mathematical conditions for this for the partial derivatives of the reaction velocities with respect to the affinities, are derived.

A. J. TAYLOR

541.123

8727. The exchange reaction between iodine and methyl iodide. H. BEHRENS AND A. G. MADDOCK. Letter in *J. chem. Phys.*, **22,** 1139 (*June*, 1954).

A description of how the reaction was identified is given. The half-life was found to fall from 45 days at 300 mg of iodine per litre to a few hours at 4 mg per litre. It is suggested that such exchange processes must be, at least, partly responsible for the effect of dissolved halogen on the retention of radioactive halogen in organic molecules after these have been irradiated with slow neutrons.

W. GOOD

541.126 : 536.46

8728. Precombustion reactions in hydrocarbon diffusion flames: The paraffin candle flame. S. R. SMITH AND A. S. GORDON. Letter in *J. chem. Phys.*, **22,** 1150–1 (*June*, 1954).

Results of sampling with probes are given. Samples were fractionated into five cuts and analysed with a mass spectrometer. The precombustion reactions are mainly cracking to unsaturated hydrocarbons.

A. G. GAYDON

541.127

8729. Kinetics of the reaction of sodium bromomalonate with thiosulphate. E. S. AMIS AND W. J. BROACH. Letter in *J. chem. Phys.*, **22,** 952–3 (*May*, 1954).

The plots of reciprocal of concentration of one of the initially equimolecular reactants against time show straight-line portions after a period of decreasing slope; from the final slopes second-order velocity constants have been calculated. These are tabulated as functions of temperature and of dielectric constant of the methanol–water medium. The results are in disagreement with the Scratchard theory for ionic reactants of like sign. The reaction is about 10^5 times slower than the corresponding one with ethyl bromomalonate and thiosulphate, presumably because of the absence in the latter case of great Coulomb repulsions.

A. J. TAYLOR

541.127 : 539.13

Reaction velocity and molecular collisions. Activated complex. *See Abstr.* 8478

541.127 : 539.16

8730. Investigation of the kinetics of the hydration of the minerals of cement clinker by the method of isotope exchange. A. M. SMIRNOVA AND P. A. REBINDER. *Dokl. Akad. Nauk SSSR*, **96,** *No.* 1, 107–10 (1954) *In Russian.*

Suspensions of $3CaO \cdot Al_2O_3$, $3CaO \cdot SiO_2$ and $2CaO \cdot SiO_2$, the particles of which had passed a 350 mesh sieve, were placed in contact with 2·5% aqueous suspensions of $CaCl_2$ containing radioactive Ca^{45}. The loss of activity from the solution to the suspended particles was measured against time. The rate of isotopic exchange seems to be characteristic of the initial rate of hydration of these minerals. The exchange with $3CaO \cdot Al_2O_3$ was 80% after ½ hour, with $3CaO \cdot SiO_2$ was 65% after 28 days and with $2CaO \cdot SiO_2$ was only 20% after 60 days.

A. L. MACKAY

ELECTROCHEMISTRY 541.13

541.133

8731. Effect of a foreign electrolyte on the diffusion of different phosphate anions in a gelatin gel. S. CORDIER, R. MARIGNAN AND J. SALVINIEN. *C.R. Acad. Sci.* [*Paris*] **238,** 1710–11 (*April* 26, 1954) *In French.*

Presents the results of measurements, by means of radioisotopes [Abstr. 7782 (1954)] of the true coefficients of diffusion in a gelatin gel for H_3PO_4 and some of its salts in the presence of foreign electrolytes (NaCl, KCl, LiCl, NaBr, NaI). It is found that the true coefficient of diffusion of the phosphate anions examined increases as the mobility of the foreign cation increases. The value of this coefficient is not determined solely by the conductivity of the other electrolyte.

F. LACHMAN

541.133

8732. An explanation of certain types of curves found in high-frequency techniques. H. W. HAMME, E. L. GROVE AND J. L. KASSNER. Letter in *J. chem. Phys.*, **22**, 944 (*May*, 1954).

The differently shaped (V- and inverted V-) curves obtained with different constant frequencies showing the variation of high-frequency conductance during the titration of dilute HCl with dilute NaOH solutions are explained by considering the individual high-frequency-conductance *v.* frequency-curves of water, HCl-, NaOH- and NaCl-solutions. W. GOOD

541.133

8733. Electrical conduction in halide-contaminated ice. E. J. WORKMAN, F. K. TRUBY AND W. DROST-HANSEN. Letter in *Phys. Rev.*, **94**, 1073 (*May* 15, 1954).

Previous work by the authors on the electrical properties of halide-contaminated ice has suggested that the conduction in the material is electronic. An experimental re-examination of the conduction process now leads to the conclusion that it is ionic.

M. R. HOPKINS

541.135 : 539.16

8734. Application of radioactive tracers for the investigation of partial intensities of discharge during electrolysis. R. AUDUBERT, J. PÉRANO AND T. MALLET. *C.R. Acad. Sci.* [*Paris*] **238**, 1881–3 (*May* 10, 1954) *In French.*

The overvoltage of the Ni^{++} ion is determined in an electrolyte of 240 g/l. of $NiSO_4 . 7H_2O$ to which known quantities of radioactive $NiSO_4$ or $NiCl_2$ have been added and to which variable potentials are applied for given periods; the weights of Ni deposited during the electrolysis are obtained from the variations of their radioactivities. The ionic overvoltage curves are found to represent the variations of the current intensity during electrolysis when measured as a function of the electrode potential. Such representation is only valid if the discharge of the ion considered is 100%. The results establish that the determination of the partial intensity of an ion may be made by means of radioactive tracers. H. H. HODGSON

PHOTOCHEMISTRY. RADIATION CHEMISTRY 541.14/.15

541.14 : 535.371

8735. Radiation chemistry of luminescent solutions. M. BURTON AND W. N. PATRICK. Letter in *J. chem. Phys.*, **22**, 1150 (*June*, 1954).

The protective effect of energy transfer to the solute from the solvent in decreasing photochemical decomposition in benzene is studied. For *p*-terphenyl or anthracene in benzene there is no perceptible inhibition of photochemical action but *m*-terphenyl gives a real effect and has a higher solubility than the other two.

G. F. J. GARLICK

541.15

8736. The decomposition of nitrogen dioxide by neutron irradiation. P. HARTECK AND S. DONDES. Letter in *J. chem. Phys.*, **22**, 953–4 (*May*, 1954).

NO_2 irradiated with neutrons in a quartz vessel yielded NO_2, almost equal quantities of N_2 and O_2, and N_2O (i.e. the reaction products do not completely recombine as in the case of ultraviolet irradiation). Chemical mechanisms are proposed. C. B. ALLSOPP

541.15

8737. Velocity–intensity relationship in the γ-ray polymerization of styrene. A. CHAPIRO AND P. WAHL. *C.R. Acad. Sci.* [*Paris*] **238**, 1803–5 (*May* 3, 1954) *In French.*

Over the range of γ-ray dosage-rates 0·29 to 370 r/min, provided by a 27 c source of Co^{60} and a 275 mc source of Ra, the rate of polymerization of styrene is proportional to the square root of dosage-rate. Deviations from this relationship recorded by other authors are discussed. C. B. ALLSOPP

541.15

8738. Chemical primary processes in the action of ionizing radiations on water: evidence from experiments with heavy water. P. KELLY, T. RIGG AND J. WEISS. *Nature* [*London*] **173**, 1130–2 (*June* 12, 1954).

A preliminary account is given of a study of the isotopic composition of the hydrogen gas which is given off from aqueous solutions enriched with heavy water when exposed to ionizing radiations. The results are interpreted as giving direct evidence of the origin of the small amounts of molecular hydrogen which is formed during the primary radiation–chemical process. C. B. ALLSOPP

DISPERSION . COLLOIDS . ADSORPTION 541.18

541.183

8739. Adsorption of a film of water on the surface of oleic acid. A. BRIN AND R. MERIGOUX. *C.R. Acad. Sci.* [*Paris*] **238**, 1808–9 (*May* 3, 1954) *In French.*

Fine droplets of water (I) condense from the saturated vapour on to a surface of oleic acid (II) and they grow in size with time; they have the form of a spherical cap and by an analysis of the dimensions of the cap, and knowing the surface tension of II and the interfacial tension between II and I, the surface tension of the oleic acid in between the droplets is calculated to be 37 dyne. cm^{-1}, i.e. 6 dyne. cm^{-1} in excess of normal; this is taken as evidence that water is adsorbed on the surface of the oleic acid.

S. J. GREGG

541.183 : 531.724

8740. The interaction of rare gas atoms with surfaces. W. A. STEELE AND G. D. HALSEY, JR. *J. chem. Phys.*, **22**, 979–84 (*June*, 1954).

The apparent volumes of vessels containing high surface-area powders have been measured with rare gases and analysed. The interaction energies and distances of closest approach have been evaluated. A new method for the estimation of surface area is presented. A.

541.183 : 536.413

8741. The expansion of porous glass on the adsorption of non-polar gases. D. J. C. YATES. *Proc. Roy. Soc. A*, **224**, 526–44 (*July* 22, 1954).

The design and construction of an absolute dilatometer of high sensitivity to measure the small

expansions resulting from the adsorption of non-polar gases on to porous glass at liquid-air temperatures are described. The expansions measured with this instrument are the first recorded with a rigid adsorbent for the case in which the adsorption is, with certainty, physical in nature. Experiments in which the gases argon, nitrogen, oxygen, hydrogen and krypton were used as adsorbates are reported. The effect of organic matter adsorbed on to the glass from the atmosphere, of unknown composition, on the expansion characteristics is indicated. A technique for the removal of this organic matter *in situ* without affecting the area of the glass is described. The results confirm the correctness of an equation previously derived by the author [Abstr. 4708 (1952)]. A.

541.183.022

8742. On the "collapse" of protein films and its application to the measurement of the area of a surface molecule. N. BENHAMOU. *C.R. Acad. Sci.* [*Paris*] **238,** 1316–18 (*March* 22, 1954) *In French.*

The surface-tension curve of a compressed protein film shows a point of inflexion comparable to the point of "collapse" found for fatty acids; from this phenomenon the area of a surface molecule of human oxyhaemoglobin has been determined. It varies between 3000 and 3500 Å^2 according to the pH of the liquid support. This area remains practically constant when the molecule is cut into two pieces.

A. J. TAYLOR

541.183.5 : 539.155.2 : 539.232

8743. Fractionation of oxygen isotopes during the formation of metal oxide films. M. DOLE AND G. A. LANE. Letter in *J. chem. Phys.*, **22,** 949–50 (*May*, 1954).

Tabulates the experimentally determined fractionation factors for the chemisorption of O (O^{16} and O^{18}) on steel and Cu. A significant fractionation is found to occur; the fractionation factor is significantly different for the two metals. F. LACHMAN

CHEMICAL STRUCTURE 541.2/.6

541.57

8744. Bond energies and polarities. M. L. HUGGINS. *J. Amer. Chem. Soc.*, **75,** 4123–6 (*Sept.* 5, 1953).

New values of electronegativities and non-polar bond energy contributions, for use with Pauling's assumed relationships involving these quantities, have been computed and tested. Using these, the calculated bond energies agree with the experimental values within 2 or 3 kcal/mole, in most cases. A.

541.57 : 532.7

8745. Hydrogen bonding and the volume of water. K. GRJOTHEIM AND J. KROGH-MOE. Letter in *Nature* [*London*] **173,** 774 (*April* 24, 1954).

It is assumed (1) that all hydrogen bonds in water (formed below 174°c) affect the ideal liquid in the same way; (2) that ice exhibits the same thermal expansion above 0°c as immediately below. The molecular fraction of H-bonds is calculated as a function of temperature, being 0·44 at 0°c, 0·23 at 100°c. Application of the mass-action law shows that the enthalpy change for H-bond formation is 2·6 kcal/mole, the entropy change being 8·9 cal/mole. Effects of van der Waals forces will be superimposed upon those of H-bonding, producing by comparison only loose orientation. A. J. TAYLOR

541.6 : 539.132

8746. The calculation of bond orders, resonance energies, and orbital energies by a simple perturbation method. M. J. S. DEWAR AND R. PETTIT. *J. Chem. Soc.*, **1954,** 1617–24 (*May*).

By using the perimeter model as a basis and by considering the introduction of cross links as a perturbation, an estimate of the resonance energies, orbital energies and bond orders of polycyclic aromatic hydrocarbons can be obtained in a much simpler manner than by the usual L.C.A.O. procedure. A linear correspondence exists for the values of the resonance energies predicted by the two methods; there is also a close agreement for the orbital-energy estimates. Some differences do occur between the two methods in the calculated bond orders and predicted bond lengths: a comparison with the experimental values for naphthalene and anthracene shows the L.C.A.O. method and the simpler new method to be about equal in the accuracy of their predictions.

A.

541.6 : 539.132

8747. A molecular-orbital theory of organic chemistry. VII. The additivity of bond energies in unconjugated systems. M. J. S. DEWAR AND R. PETTIT. *J. Chem. Soc.*, **1954,** 1625–34 (*May*).

For earlier parts, see Abstr. 3701 (1953). The problem of additivity of bond energies in unconjugated compounds is discussed. The effect of interactions between localized bonds is calculated by perturbation theory, and it is found that the effect of such interactions vanishes to a first approximation. The second-order effects can to a large extent be absorbed into the empirical bond energies. In this way the additivity of bond energies in such compounds is explained without postulating localization of electrons in specific bonds. Departures from additivity are satisfactorily interpreted and relations obtained which are shown to be in close agreement with experiment. It is deduced that the important interactions are those between adjacent bonds rather than 1 : 3 interactions of the type postulated in hyperconjugation. The present treatment avoids most of the assumptions made in the usual M.O. treatment and its conclusions should be correspondingly reliable. A.

541.64

8748. Depolymerization of macromolecules under the simultaneous actions of ultrasonic and electric fields. P. RENAUD AND J. SADDY. *C.R. Acad. Sci.* [*Paris*] **238,** 1393–4 (*March* 29, 1954) *In French.*

Solutions of (1) polymethyl methacrylate, (2) polyvinylchloride, (3) polystyrolene in pyridine, showed no change in viscosity under the action of a 1 Mc/s ultrasonic field at 25 watts, the maximum power available; an electric field of ~1 kV/cm produced only electrolytic effects, the viscosity not changing. Extensive data are given on the viscosity changes

observed under the action of both fields simultaneously on (1). The electric field could then be steady, alternating or pulsed. It is concluded that depolymerization is caused by the uncoiling of the molecules, which occurs because the carbonyl groups become ionized in the electric field. A. J. TAYLOR

541.64 : 548.5

Crystallization phenomena in polymers. *See Abstr.* 8759–61

CHEMICAL ANALYSIS 543/545

545.7 : 539.172.4

8749. Composition, decontamination of radioactive gas mixtures. H. M. BUSEY. *Nucleonics*, **12**, 9–13 (*May*, 1954).

A procedure for analysing the gases evolved from the Los Alamos "water boiler" reactor is described. Determinations of CO_2 and H_2O vapour were made by freezing out these components; H_2 was estimated by combustion, O_2 by oxidation of hot Cu, N_2 by reaction with hot U turnings, and inert gases by difference and observation of the colour of electrical discharges in the gas. Methods of safe disposal of the radioactive gases, including removal of the activities by active charcoal, are discussed. L. R. SHEPHERD

545.82

8750. X-ray and infrared study of some limestones made by living beings. T. POBEGUIN. *J. Phys. Radium*, **15**, 410–12 (*May*, 1954). *In French.*

545.822

8751. On a new method of analysis by infrared absorption. Selective modulation. K. F. LUFT. *C.R. Acad. Sci.* [*Paris*] **238**, 1651–3 (*April* 21, 1954) *In French.*

"White" radiation passes through a wedge cell *W* rotated at 5 rev./sec, causing a periodic intensity variation for those wavelengths partially absorbed by *W*, and then through a test material *C* to a detector and amplifier which responds only to the modulated radiation. It is found that if *W* contains cyclohexane (*X*) in CCl_4, it is possible to detect at *C* 10^{-3} % of *X* in benzene. G. F. LOTHIAN

CRYSTALLOGRAPHY 548

548.24

8752. The influence of zonal and sectorial structure on the distribution of twins (domains) in a crystal of Rochelle salt. M. A. CHERNÝSHEVA. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 1, 87–8 (1953) *In Russian.*

It is shown experimentally that the distribution of domains in a crystal is conditioned by the zonal and sectorial structure of the crystal. It is very probable that the twinning of Rochelle salt is a secondary phenomenon arising on polymorphic transformation as a result of the relief of internal strains, conditioned both by the transition from orthorhombic to monoclinic symmetry and also by non-uniformities of structure connected with the growth of the crystal.

A. L. MACKAY

548.4 : 537.311.33

8753. Type IIb diamonds. J. F. H. CUSTERS. Letter in *Physica*, **20**, 183–4 (*March*, 1954).

Type IIb diamonds form a sub-group of type II and comprise blue diamonds showing phosphorescence under 2500 Å radiation, and high dark-conductivity (in one case 5 A at 100 V for specimen 3·1 mm thick). The diamonds have Si and Mg as trace impurities but the relation of the singular properties to matrix lattice structure or to impurities is not certain.

G. F. J. GARLICK

548.5

8754. The "dew" method applied to the investigation of the spiral steps of [crystal] growth. N. V. GLIKI. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 4, 541–3 (1953) *In Russian.*

Lemmlein's "dew" method [*Dokl. Akad. Nauk SSSR*, **58**, *No.* 9, 1939 (1947)] consists in directing a current of warm humid air on to a cleaned and grease-free surface of a crystal. When impinging on the cold surface, the water vapour forms droplets of microscopic size, mainly on the negative (concave) portions of the surface (i.e. the active centres), thus revealing the complex picture of the hyperfine micro-relief. This method was applied to the investigation of the hyperfine growth spirals and other surface details on the (0001) face of SiC crystals. The "two-dimensional" growth nuclei, of triangular shape, are distributed orderly; the majority of the triangles are concentrated near the apex of the spiral step [dislocation]. F. LACHMAN

548.5

8755. Growth spirals on crystals of long-chain compounds. N. G. ANDERSON, I. M. DAWSON AND D. H. WATSON. Note in *Naturwissenschaften*, **41**, *No.* 9, 211 (1954).

Comments on paper by Amelinckx [Abstr. 3981 (1954)] and describes briefly some related results. Crystals of *n*-pentacontanol-1 (n-$C_{50}H_{101}OH$) grown from xylene show monomolecular growth steps and thus differ from Amelinckx's observations on $C_{26}H_{53}OH$ from benzene. The authors doubt whether the cross-lacing observed by Amelinckx was due to polytypism and reproduce an electron micrograph of a crystal of *n*-propyl-pentacontonoate (n-$C_{53}H_{106}O_2$) in support of their explanation of the effect as a punch-through of the underlying growth spiral to the upper surface of the crystal.

S. WEINTROUB

548.5

8756. Direct observation of polygonization in rock-salt. S. AMELINCKX. Letter in *Nature* [*London*] **173**, 993–4 (*May* 22, 1954).

Rocksalt crystals were plastically bent, annealed at 600°C, and then cleaved. The cleavage faces were

silvered and examined under the polarizing petrographic microscope and by the method of Françon [Abstr. 3525 (1952)]. Lines parallel to the polygon boundaries were clearly seen. A. R. STOKES

548.5

8757. Vapor phase crystal growth of lead sulfide crystals. F. PIZZARELLO. Letter in *J. appl. Phys.*, **25,** 804–5 (*June*, 1954).

Pb and S were reacted in a sealed quartz tube, which was then placed in a Bridgman furnace with an inverted thermal distribution; the tube was raised at the rate of $\frac{1}{16}$ in/hr. Formation of crystals occurs at ~ 950°C, source temp. is 1100°C. Single crystals of *p* and *n* type PbS were obtained with resistivities of 0·05 ohm.cm. J. FRANKS

548.5 : 537.311.33

8758. Observations on CdS crystals by microscopic examination and conductivity measurements. L. HERFORTH AND J. KRUMBIEGEL. *Z. Naturforsch.*, **9a,** 432–4 (*May*, 1954) *In German.*

It is found that single crystals can be better grown by sublimation of CdS than by direct preparation from Cd in an H_2S atmosphere. The striations on the crystals run parallel to the *c*-axis of the lattice. Single crystals show *in vacuo* about 40% greater mean conductivity than twinned crystals. Crystal types can be sorted with interesting anisotropy of conductivity. In air the conductivity is enhanced with some rectification attributed to an adsorbed layer of water molecules.

G. F. J. GARLICK

548.5 : 541.64

8759. Crystallization phenomena in polymers. I. Preliminary investigation of the crystallization characteristics of polyethylene terephthalate. A. KELLER, G. R. LESTER AND L. B. MORGAN. *Phil. Trans A*, **247,** *No.* 921, 1–12 (1954).

An exploration has been made of the factors that affect the rates of crystallization of polyethylene terephthalate and the effect of the crystallization conditions on the crystalline state of the polymer. The rate and course of the crystallization is affected by molecular structural features such as molecular weight, the temperature of the crystallization and by a number of physical factors arising in the fabrication of the sample. These last factors include those arising in the melting of the polymer prior to the crystallization and also the previous crystalline state of the polymer prior to melting. All these factors also affect the resulting crystalline state of the polymer in terms of "grain size," and the temperature of the crystallization also affects the degree of order of the crystalline arrangement of the polymer molecules. A.

548.5 : 541.64

8760. Crystallization phenomena in polymers. II. The course of the crystallization. L. B. MORGAN. *Phil. Trans A*, **247,** *No.* 921, 13–22 (1954).

From what is now known of the fine structure of crystallized polymers and the general features of the crystallization processes in polyethylene terephthalate described in Pt I, mechanisms whereby randomly arranged long polymer molecules move into a semi-crystalline order are surmised. These are shown to yield kinetical equations for the processes which fit the experimental observations of Pt I. A.

548.5 : 541.64

8761. Crystallization phenomena in polymers. III. Effect of melt conditions and the temperature of crystallization on the course of the crystallization in polyethylene terephthalate. F. D. HARTLEY, F. W. LORD AND L. B. MORGAN. *Phil. Trans A*, **247,** *No.* 921, 23–34 (1954).

A detailed analysis has been made of the course of crystallization at different temperatures and from different preceding melt temperatures. The theoretical deductions based on the mechanisms surmised in Pt II and kinetical analysis of the density changes with time have been confirmed by direct microscopic examination of the resulting structures. The crystallization constant K in the expression $\theta = e^{-Kt^n}$, which can be obtained from the analysis of the density-time curves, contains nucleation and growth constants. Measurement of these, on microtomed sections of polymer crystallized for various lengths of time, enables the value of K to be calculated by an independent method. Good agreement is obtained between the values of K ascertained by both methods. The value of n can be 2, 3 or 4 in the case of polyethylene terephthalate, depending on the nucleation and growth processes involved. These vary with the temperature of the crystallization, and the transition temperatures at which n changes in value can be varied by adjusting the previous melt history of the polymer. The direction in which these transition temperatures can be varied by adjusting the melt conditions accords with the theory given in Pt II. A.

548.51

8762. Nucleation phenomena arising during the dehydration of solid hydrates. W. E. GARNER AND T. J. JENNINGS. *Proc. Roy. Soc. A*, **224,** 460–71 (*July* 22, 1954).

The lattice vacancies formed on the evaporation of water molecules from the surfaces of potassium chrome alum have little mobility within the crystal. Treatment of crystals of potassium and ammonium chrome alums and copper sulphate pentahydrate in hard vacuum produces a change in the surface which under the catalytic action of water vapour gives rise to nuclei of the solid products. Common alum does not show these phenomena. The anomalous activation energies of the interface reactions of hydrates are discussed. A.

548.517 : 541.64

8763. Molecular structure and the crystallinity of long-chain polymers. C. W. BUNN. *J. appl. Phys.*, **25,** 820–5 (*July*, 1954).

The molecular characteristics which determine whether a long-chain polymer will crystallize at all—and if so, how readily—are considered. The criterion for crystallization is geometrical regularity of molecular structure; but absolute regularity is not essential, for certain copolymers, as well as certain homopolymers with geometrically irregular structures, do crystallize; the requirement is that the different units which indiscriminately occupy corresponding positions in the structure must be not too different in size and shape (as in monomeric "mixed crystals"); an approximation to regularity is sufficient. It is unlikely that quite regular molecules can be incapable of

crystallizing; when such substances are reported as non-crystalline, it is more likely that they crystallize only with difficulty, and the right conditions have not been found. Reluctance to crystallize is associated with a small interval between relaxation transition ("second-order transition") and melting points; this interval appears to be influenced by the general shape of the molecule (though shape is not the only factor). The temperature range within which crystallization proceeds at an appreciable rate may be still further restricted if the chain repeat distance of the molecules is long; and this same factor may make crystallization at any temperature very slow. A.

548.517 : 541.64

8764. Relationship to first- to second-order transition temperatures for crystalline high polymers. R. F. Boyer. *J. appl. Phys.*, **25**, 825–30 (*July*, 1954).

Concerns an empirical linear relationship between the melting temperature T_1 and the second-order or glassy transition temperature T_2 for partially crystalline polymers. Two lines can be drawn, one for symmetrical polymers, the other for unsymmetrical polymers, the latter being of lower slope. These families are only approximate. It is shown for a limited group of polymers, that T_2 is proportional to the cohesive energy density of the polymer. Since $T_1 = \Delta H/\Delta S$, it is suggested that the two families of curves arise because of differences in ΔS which depends on symmetry and chain stiffness. It is shown that T_1 and T_2 are linearly related with diluent as a common parameter. A.

548.517 : 541.64

8765. Crystallization kinetics in high polymers. I. Bulk polymers. L. Mandelkern, F. A. Quinn, Jr and P. J. Flory. *J. appl. Phys.*, **25**, 830–9 (*July*, 1954).

The rates of crystallization of five polymers, poly-(ethylene oxide), poly-(decamethylene adipate) and three poly-(N, N′-sebacoyl piperazine)'s differing in molecular weight, have been observed dilatometrically at various temperatures ranging from 5·5 to 24° below the respective melting points T_m. The crystallization isotherms are remarkably reproducible, and the previous thermal history above the melting point is without effect provided that melting is completed before the crystallization experiment is begun. The crystallization isotherms display induction periods. The very large temperature coefficients observed are uniform throughout the crystallization process, i.e. isotherms at different temperatures are superimposable by rescaling the time. It is inferred from this and other evidence that steady-state nucleation and growth occur simultaneously throughout the process. The results are satisfactorily interpreted by applying conventional nucleation theory and assuming that nuclei grow at rates proportional to their surface areas. The treatment resembles that applied to crystallization in metals. Spherical and disk-shaped nuclei are considered, but the data do not discriminate between them. An extension of the theory accounts for the maximum commonly observed in the crystallization rate as the temperature is decreased below the range of the present measurements. A.

548.517 : 541.64

8766. X-ray and infrared studies on the extent of crystallization of polymers. J. B. Nichols. *J. appl. Phys.*, **25**, 840–7 (*July*, 1954).

The current X-ray and infrared techniques for estimation of the crystalline-amorphous ratio in polymers are surveyed. Representative data are assembled for some of the common crystallizing polymers. Advantages and limitations of the methods are pointed out. A.

548.517 : 541.64

8767. An infrared study of the crystallization of polyethylene. F. P. Reding and A. Brown. *J. appl. Phys.*, **25**, 848–50 (*July*, 1954).

The melting point, temperature for the onset of crystallization and the isothermal rate of crystallization of polyethylene all decrease on increasing the extent of branching of the polymer chains. In the molecular weight range studied the melting point is independent of the molecular weight. The temperature for the onset of crystallization at any given rate of cooling appears to increase as the molecular weight is decreased. The isothermal rate of crystallization becomes much greater as the crystallization temperature is lowered, however, at a given temperature the rate is affected only slightly by a change in molecular weight and is primarily a function of the degree of branching. A.

548.517 : 541.64

8768. Crystallization in butadiene-styrene copolymers. L. A. Wood. *J. appl. Phys.*, **25**, 851–4 (*July*, 1954).

Butadiene-styrene copolymers contain the following units: *trans*-1, 4-polybutadiene, *cis*-1, 4-polybutadiene, 1, 2-polybutadiene, and bound styrene. Of these the first is the only type which has been shown to form crystals. By the use of published data on volume change arising from crystallization (largely due to Meyer) and on structure as a function of polymerization temperature (largely due to Hampton) it is found that crystallization in emulsion polymers has been observed only when the *trans*-1, 4-polybutadiene content has been greater than about 58%, becoming more complete the more this value is exceeded. From this observation one can then draw the following conclusions, all of which are in accordance with direct experimentation: (1) crystallization is not observed if the polymerization temperature is above 60°C; (2) for polymerizations at 50°C a small amount (2 to 6%) of bound styrene inhibits crystallization completely; (3) for polymerizations at 5°C the limit is at about 15 to 18% bound styrene content; (4) at −40°C (the lowest polymerization temperature normally utilized) this limit is at about 30% bound styrene. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7 : 538.22

Crystallography and magnetism. *See Abstr.* 8418

548.7 : 535.43

Theory of the scattering of light by a cubic crystal. *See Abstr.* 8213

548.7 : 537.581

Work function and electron emission of non-metallic crystals. *See Abstr.* 8390

548.7 : 539.11

The electronic structure of the borides MB_6. *See Abstr.* 8474

548.7

8769. Diffusion of lattice defects in a temperature gradient. R. W. KEYES. Letter in *Phys. Rev.*, **94,** 1389 (*June* 1, 1954).

There are two contributions to the diffusion flow, one due to the gradient in density of defects [see Abstr. 801 (1954)] and the other directly to the gradient of temperature dT/dx. The latter is shown thermodynamically to be $-D_v(N_v/kT^2)q^*(dT/dx)$ where D_v and N_v are the diffusion coefficient and density of vacancies and q^* is the heat of transport; q^*, the sign of which determines the direction of flow of defects, is not necessarily to be interpreted in the way proposed by Le Claire [Abstr. 6030 (1954)] and Brinkman [Abstr. 6031 (1954)]; an alternative interpretation based on a model of Wirtz [*Phys. Z.*, **44,** 221 (1943)] is suggested. A. D. LE CLAIRE

548.7 : 537.311.33

8770. The effect of environment on the production of thermal lattice defects in crystals. Z. TROUSIL. Letter in *Czech. J. Phys.*, **4,** 98–9 (*Feb.*, 1954).

Crystals of *n*-type germanium partly immersed in melts of various metals and held at high temperature, remain *n*-type in those regions in contact with the melt but become *p*-type elsewhere. Conversion to *p* is attributed to a diffusion inwards of thermal defects produced at the surface, and it is supposed that this process does not occur at the immersed surfaces which therefore remain *n*. A. D. LE CLAIRE

548.7 : 539.374

Lattice imperfections and plastic deformation in metals. *See Abstr.* 8718

548.7 : 539.11

Bound states in dislocations. *See Abstr.* 8472

548.7 : 539.185

8771. The pile irradiation of quartz crystal oscillators. F. B. JOHNSON AND R. S. PEASE. Letter in *Phil. Mag.*, **45,** 651–4 (*June*, 1954).

Two effects are noted: an initial effect consisting of a rapid reduction of frequency with dose, accompanied by a darkening, exactly as with X-ray irradiation; and an effect occurring with increasing dose, which consists of a slow linear reduction of frequency, accompanied by a bleaching out of the previous discoloration. The first effect is due to ionization and the second to the creation of further defects by the displacement of atoms by fast neutron bombardment. Changes of lattice parameter are also noted. A crystal irradiated for 16 000 MWhr ($\sim 10^{19}$ neutrons/cm^2) became quite transparent and on irradiation by X-rays showed almost no colour change and an increase in frequency. The bleaching of the ionization effects by pile irradiation is due, therefore, not to the elimination of the previous defects but to some mechanism which reduces their effectiveness as electron traps. J. THEWLIS

548.7

8772. Intercrystalline films in single crystals of alkali halide salts and some of their properties. L. M. SHAMOVSKIĬ AND L. M. RODIONOVA. *Dokl. Akad. Nauk SSSR*, **92,** *No.* 5, 939–42 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-221.*

Addition of metal impurities such as Ag to KCl lowers the probability of *F*-centre formation either in an electric field or by additive coloration. It is assumed that *F*-centre electrons are trapped in the deeper Ag levels. The effect of Ag on *F*-centre formation varies with the crystal. *F*-centres are still observed in NaCl with 5 mol % Ag but cannot be formed in KCl with 0·5 mol % Ag. It is postulated that the impurity collects at intercrystalline surfaces. G. F. J. GARLICK

548.7

8773. On the knowledge of photochemically sensitized alkali halide crystals. G. MIESSNER AND R. W. POHL. *Z. angew. Phys.*, **6,** *No.* 5, 218–19 (1954) *In German.*

The maximum of the *U*-centre absorption band due to H^- ions in alkali halides shows the same behaviour as the *F*-band for mixed crystal systems, its energy or frequency position decreasing with lattice constant in a near linear manner. (Systems KCl–KBr and KCl–RbCl.) G. F. J. GARLICK

548.7

8774. Contribution to the study of *F*-centres in alkali halides. G. PERNY. *J. Phys. Radium*, **15,** 356–8 (*May*, 1954) *In French.*

548.7

8775. Electron resonance in *F* centres. J. KORRINGA. Letter in *Phys. Rev.*, **94,** 1388–9 (*June* 1, 1954).

548.7

8776. Multiphonon transitions in the *F* center. J. J. MARKHAM. Letter in *Phys. Rev.*, **94,** 1395 (*June* 1, 1954).

The probability of non-radiative transitions of excited electrons in *F*-centres to their ground state with simultaneous emission of many phonons is investigated. If marked ionic displacement occurs between the excited and ground states then multiphonon emission processes become more rapid than those for photon emission and are thus preferred. G. F. J. GARLICK

548.7

8777. Color centers in synthetic quartz. G. W. ARNOLD, JR. Letter in *J. chem. Phys.*, **22,** 1259–60 (*July*, 1954).

548.7 : 537.58

8778. On the colour centres in fluorite. A. BOHUN. Letter in *Czech. J. Phys.*, **4,** 89–91 (*Feb.*, 1954) *In German.*

A study is made of the variation of thermionic emission with temperature for fluorite from various sources. Characteristic maxima occur as for other halides which are associated with specific colour centres. The nature of the latter is discussed. G. F. J. GARLICK

548.7 : 539.374

8779. Effect of plastic flow upon color centers in alkali halide crystals. M. UETA AND W. KÄNZIG. Letter in *Phys. Rev.*, **94,** 1390 (*June* 1, 1954).

Crystals of NaCl electrolytically coloured are

irradiated in the *F*-band during plastic deformation at room temperature. The *F*-band is bleached rapidly, the *R*- and *M*-bands being enhanced. Plastic deformation at 77°K with *F*-band irradiation produces smaller bleaching with formation of *F'* centres but no enhancing of *R*- and *M*-bands. It is assumed that vacancies are created in plastic flow but at low temperatures do not act as traps for *F*-electrons and that on warming their aggregates are broken up and dispersed. G. F. J. GARLICK

548.7 : 537.226.2

Dielectric properties of colored KCl crystals. *See Abstr.* 8252

548.7

8780. Some phenomena at the interface boundary of alkali-halide crystals during additive discoloration. Ya. N. Pershits. *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 347–50 (1953) *In Russian.*

The crystals examined (KCl, KI, NaCl) were discoloured by Artsybyshev's method [*Dokl. Akad. Nauk SSSR*, **8**, 157 (1933)]. The main crystal was in contact, on one side, with Na metal and, on the other, with the "supplementary crystal." The whole aggregate was clamped in an iron frame and placed in an electric furnace. The discoloration was brought about either thermally or by applying an electric field (~100 V/cm). It has been found that, during the migration of *F*-electrons on the boundary, they are captured by the lattice defects, thus producing a discoloured layer near the interface. Discoloration of a crystal, due to contact, can generate a concentration of *F*-centres, lesser than that obtained when *F*-electrons are generated by a metal electrode. Some of the electrons fixed in the vicinity of interface pass into the conductivity region at a higher temperature than do electrons on *F*-levels in the interior of the crystal. F. LACHMAN

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 8696–707

548.73

8781. Diffuse X-ray scattering and the physical properties of crystals. W. A. Wooster. *Brit. J. appl. Phys.*, **5**, 231–7 (*July*, 1954).

Both the ionization and photographic methods of studying diffuse X-ray reflections are described. A brief account of the way in which the experimental observations are related to the thermal agitation of the atoms and to the elastic constants is given for the case of cubic crystals. Precipitates of one phase within another often have the geometrical form of platelets or rods. Each of these types of precipitate is associated with a characteristic type of diffuse X-ray reflection; the former with spikes in reciprocal space and the latter with disks. A review is given of the present state of knowledge concerning the anomalous X-ray scattering from diamond. New observations on the distribution of the spikes over the reciprocal points are given. It can be shown from these results that the centres of the atoms must occupy their correct positions but that the atomic planes parallel to a given cube face do not all scatter X-rays with equal intensity. The surprising conclusion follows from this that some of the carbon atoms have bonds which are not fully accounted for by the usual four tetrahedral bonds. A.

548.732

8782. Diffraction of X-rays in bent crystals. Integrated intensity of reflection for the transmission method. I. B. Borovskiĭ and P. A. Bezirganyan. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 6, 1129–32 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-226.*

See Abstr. 8067, 8068 (1953). An expression is obtained for the integrated intensity of reflection of strongly divergent X-rays; this is of the same form as that for plane waves diffracted from a plane crystal, except for a numerical factor, which is given as 10^4 for a typical case. The effect of absorption is briefly considered. A. R. STOKES

548.732

8783. Effect of lattice distortion on the scattering of X-rays by a solid solution. A. Guinier. *C.R. Acad. Sci.* [*Paris*] **238**, 1898–900 (*May* 10, 1954) *In French.*

It is shown that, in a disordered alloy structure with atoms of different radii, the diffuse X-ray scattering due to lattice distortion is negligible compared with that due to the different scattering factors of the atoms. A. R. STOKES

548.732

8784. A boundary effect on the intensity of X-rays reflected from a quartz plate. E. Fukushima. Note in *Acta cryst.*, **7**, 459–60 (*May*, 1954).

A quartz plate was ground, and then half of its surface was etched. The intensity of X-ray diffraction was found, under certain circumstances, to be greater on the boundary than on either side of it. A. R. STOKES

548.733

8785. Comparison of the advantages of the retigraph and the Weissenberg camera for the study of X-ray diffraction by crystals. J. Clastre and R. Gay. *J. Phys. Radium*, **15**, 17 S–18 S (*April*, 1954) *In French.*

Advantages claimed for the retigraph [Abstr. 5137 (1954)] are: better geometry of reflections; spot shapes all similar and therefore better for photometry; more convenient Lorentz-factor correction. A. R. STOKES

548.733

8786. Monochromatic X-rays for single crystal diffuse scattering. B. E. Warren. *J. appl. Phys.*, **25**, 814–15 (*June*, 1954).

Describes a "tilted-strip monochromator" for use in the single-crystal X-ray investigation of diffuse scattering. The monochromator is made from curved, wedge-shaped strips of crystal mounted on a concave surface, to give the effect of a monochromating crystal with a double curvature. Such a monochromator, made of LiF strips, gives a gain in intensity of about 15 over a singly bent quartz monochromator for the same volume element in reciprocal space. The $\lambda/2$ component is eliminated by the use of a balanced filter. J. THEWLIS

548.734

8787. An analytic method for the determination of shape and location of Fourier peaks. J. Ladell and J. L. Katz. Note in *Acta cryst.*, **7**, 460–1 (*May*, 1954).

Expressions are given from which the position of a

peak and the eccentricity of the elliptical contours around the peak can be found. Values of the electron density at nine mesh-points are required. A. R. STOKES

548.735

8788. Some relations for crystals with substructures. M. J. BUERGER. *Proc. Nat. Acad. Sci. U.S.A.*, **40**, 125–8 (*Feb.*, 1954).

A sub-structure is a regular arrangement of atoms of one sort with a unit cell smaller than that of the complete structure (e.g. close-packing of oxygen atoms in some oxides). It is shown how a sub-structure may be picked out of the Patterson diagram or the reciprocal-space diagram. A. R. STOKES

548.735

8789. The determination of the temperature factor. A. LÍNEK. *Czech. J. Phys.*, **4**, 26–33 (*Feb.*, 1954).

The electron cloud of an atom is assumed to become ellipsoidal owing to thermal vibration, and the parameters of this cloud are determined from the X-ray data. An example is given. A. R. STOKES

548.735

8790. The intensity of X-rays diffracted by close-stacked crystals with "stacking errors." R. GEVERS. *C.R. Acad. Sci.* [*Paris*] **238**, 1827–9 (*May* 3, 1954) *In French.*

It is shown that the expression given by Jagodzinski [Abstr. 6564 (1949)] can be reduced to a simpler form. A. R. STOKES

548.735.7

8791. The determination of crystal size in quartz and graphite on the basis of primary extinction. A. KOCHANOVSKÁ. *Czech. J. Phys.*, **4**, 34–47 (*Feb.*, 1954) *In Russian.* Summary (200 words) in English.

The size is deduced from the ratio of intensities of certain lines. The results are about right for quartz, but are an order of magnitude too high for graphite. Reasons for this discrepancy are discussed; an important one is the neglect of secondary extinction. A. R. STOKES

548.736.1

8792. Re-examination of the symmetries of iron and nickel by the powder method. F. W. VON BATCHELDER AND R. F. RAEUCHLE. Note in *Acta cryst.*, **7**, 464 (*May*, 1954).

Lattice constants of Fe and Ni, measured for a number of different planes at temperatures from 25–400°C, show no evidence of any deviation from cubic symmetry as has recently been reported. A. E. DE BARR

548.736.1 : 536.413.2 : 537.311

Structure of plutonium metal. *See Abstr.* 8263

548.736.3

8793. The structure of calcium monochloride. P. EHRLICH AND L. GENTSCH. *Naturwissenschaften*, **41**, *No.* 9, 211–12 (1954) *In German.*

548.736.3

8794. On the orientation of twin planes in hexagonal CdS crystals. K.-H. JOST. *Z. Naturforsch.*, **9a**, 435–6 (*May*, 1954) *In German.*

Diagrams are given showing the binding of atoms along the twin plane, for three modes of twinning. A. R. STOKES

548.736.3 : 539.185

8795. X-ray scattering by lattice defects in neutron-irradiated single crystals of boron carbide. C. W. TUCKER, JR AND P. SENIO. Note in *Acta cryst.*, **7**, 456 (*May*, 1954).

Neutron irradiation produces marked changes in the intensities of the X-ray diffraction maxima, corresponding to a strong, highly anisotropic temperature factor and to alterations in the average atomic positions. For an exposure of 3×10^{20} neutrons/cm^2 there is an expansion of the a-axis (referred to hexagonal co-ordinates) of 0·6% and a contraction of the c-axis of 0·8%. Marked diffuse scattering is observed. The effects are believed to be due to anisotropic bonding of displaced atoms and the preferential removal of certain atoms by the reaction of B^{10} with thermal neutrons. Thermal effects, as such, are excluded as the observed phenomena are not altered by lowering the crystal temperature to that of liquid N. J. THEWLIS

548.736.5

8796. The crystal structure of $Fe_3Br_8.16H_2O$. Z. V. ZVONKOVA. *Zh. fiz. Khim.*, **28**, *No.* 3, 453–8 (1954) *In Russian.*

X-ray examination of crystals of $Fe_3Br_8.16H_2O$, recrystallized from water, showed them to be monoclinic with space group $P2_1/c$ and cell dimensions $a = 8\cdot74$, $b = 7\cdot26$ and $c = 22\cdot94$ Å and $\beta = 90° \pm 10'$. $\rho_{obs.} = 2\cdot6$ and $Z = 2$. $h0l$ and $0kl$ Patterson projections showed the Br–Br and Br–Fe vectors and enabled the corresponding Fourier projections to be made. A table of the atomic positions is given. The unit cell contains 16 octahedra each having 4 O atoms and 2 Br atoms at its corners. Four Fe^{+++} and 2 Fe^{++} are distributed statistically between 8 of the 16 positions at the centres of the octahedra. The octahedra are linked into columns parallel to the a-axis by the sharing of corners (oxygen corners). There are common edges parallel to the b-axis. A. L. MACKAY

548.736.5

8797. The structure of colemanite, $CaB_3O_4(OH)_3.H_2O$, determined by the direct method of Hauptman and Karle. C. L. CHRIST, J. R. CLARK AND H. T. EVANS. Note in *Acta cryst.*, **7**, 453–4 (*May*, 1954).

Monoclinic, space-group $P\ 2_1/a$, $a = 8\cdot743$, $b = 11\cdot264$, $c = 6\cdot102$ Å, $\beta = 110° 7'$. Details are given of the numbers of F^2 values used and the numbers of signs of F's obtained directly. The structure is described. A. R. STOKES

548.737

8798. s-Triazine. I. The unit cell. L. A. SIEGEL AND E. F. WILLIAMS. Letter in *J. chem. Phys.*, **22**, 1147–8 (*June*, 1954).

Optical and X-ray examination indicate a rhombohedral unit cell, $a = 6\cdot11$ Å, $\alpha = 104\cdot8°$, with two molecules per cell; probable space-group $R3c$, which means that the molecules must be planar. A. R. STOKES

548.74

8799. Diffraction of electrons. I. On the theory of electron diffraction by parallelepipedal crystals. K. MOLIÈRE AND H. NIEHRS. *Z. Phys.*, **137**, *No.* 4, 445–62 (1954) *In German.*

This is the first of a series of papers in which electron

diffraction fine-structure is used to test the dynamic theory of diffraction. It deals theoretically with the dynamic theory as applied to a crystal fragment bounded by non-parallel sides and to one with the shape of a parallelepiped. J. THEWLIS

548.74

8800. The intensity of high angle Kikuchi bands. M. BLACKMAN AND I. A. KHAN. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 553–5 (*June*, 1954).

The intensities of the high angle (up to 164°) Kikuchi bands from natural and fused quartz are found to be the same. It is concluded that the mechanism responsible for the high intensity at large scattering angles is not a "lattice" effect.

J. THEWLIS

GEOPHYSICS 55

550.38

8801. Natural magnetization of igneous and sedimentary rocks. D. H. GRIFFITHS AND R. F. KING. *Nature* [*London*] **173**, 1114–17 (*June* 12, 1954).

Report of a conference held during January 8–9 in the Geology Department of the University of Birmingham.

550.384

8802. Reversals of the main geomagnetic field. I. J. HOSPERS. *Proc. K. Ned. Akad. Wetensch. B*, **56**, 467–76 (*Nov.–Dec.*, 1953).

Data on the history of the geomagnetic field was sought from measurements of the direction of permanent magnetization of igneous and sedimentary rocks. Many instances of igneous rocks show permanent magnetization approximately opposite in direction to the present field. This may be due to a property of the igneous rock which on cooling produces reverse magnetization in a normal field, or ordinary thermo-remanent magnetism acquired in a reversed field. Preliminary results are given of measurements of datable sediments around the volcano Hecla (Iceland) from approximately 5×10^7 years ago to 1947–48. These include (1) historic, (2) postglacial, (3) early quaternary, (4) tertiary plateau, and (5) sediments. For (1) the vertical component is downwards and for (3) upwards. Those of (2) show the magnetic pole centred on the geographical pole. In (4) there are alternate zones of normal and reversed magnetization. The results are tabulated and a stratigraphic column for Iceland is given. R. S. READ

550.384

8803. Reversals of the main geomagnetic field. II. J. HOSPERS. *Proc. K. Ned. Akad. Wetensch. B*, **56**, 477–91 (*Nov.–Dec.*, 1953).

From examination of samples of various groups of lava it is concluded that the mean duration of permanent magnetization is consistently more in agreement with the dipole and for normally (N) magnetized Tertiary specimens it originated before the tectonic movements. It has been stable in direction for several million years. It is of thermoremanent origin, was acquired during the initial cooling, and has been stable ever since. For reversed (R) natural magnetization Néel's proposed mechanisms with changes in the lattice for tetrahedral and octahedral types, and later selective chemical changes, are examined and checked by laboratory tests. It is concluded with reservations that only the assumption of a repeatedly reversing magnetic field is satisfactory and thus is confirmed by striking similarities between N and R magnetization.

R. S. READ

550.384

8804. Reversals of the main geomagnetic field. III. J. HOSPERS. *Proc. K. Ned. Akad. Wetensch. B*, **57**, 112–21 (*Jan.–Feb.*, 1954).

Icelandic rocks have preserved a record of a repeatedly reversing magnetic field. The reversal is through 180° and apparently worldwide with a reversal of the polarity of the earth's magnetization in a way not yet known. The period of reversal is given as $2\cdot5$ to 5×10^5 years with the change occurring in 2 to 20×10^3 years. Four reversals of field are known but it has apparently occurred since at least Miocene times, 2×10^7 years ago. In examination of other works the views are not in serious disagreement. In relation to continental drift theories, Iceland appears, within the limits of experimental accuracy, to have suffered no rotation and no changes in latitude since Miocene times. The position of the geographic pole in Miocene times given by workers on polar wandering is outside possible limits and the theory of polar wandering is not supported.

R. S. READ

550.384 : 523.74

Relationship between appearance of the yellow coronal line and geomagnetic activity. *See Abstr.* 8004

550.838

8805. Location of deep-lying unexploded bombs. H. WEGENER AND R. FLEISCHMANN. *Z. angew. Phys.*, **6**, *No.* 3, 120–7 (1954) *In German.*

The following problem is posed: an unexploded bomb lies deeply-buried in the earth and is to be removed. It is required to know (1) the position of the bomb; (2) the direction of the bomb's axis in space, and (3) the volume of the bomb. The answers to these questions are obtained by field determinations of the change of the earth's magnetic field due to the presence of the bomb, carried out by use of Förster's differential probes [*Z. angew. Phys.*, **2**, 210 (1950)] which can be inserted into boreholes to a depth of 20 metres. The mathematical theory of the method is discussed by replacing the bomb by a dipole, and the practical application of the theory is illustrated in the recovery of an unexploded bomb that fell in Hamburg. J. S. G. THOMAS

ATMOSPHERE . METEOROLOGY 551.5

551.510.535

8806. On the dynamo theory of geomagnetic tides. I. LUCAS. *Arch. elekt. Übertragung*, **8**, 123–31 (*March*, 1954) *In German.*

Plasma theory is used to treat the interaction between the tidal oscillations of the earth's atmosphere and the electric current system existing in the ionosphere. The numerical integration of the appropriate differential equation yields a tidal variation of the terrestrial magnetism of the right order provided a velocity amplitude of 60 cm/sec is assumed for the tidal oscillation at the height of the *E*-layer. Large amplitudes are predicted for the magnetic tides in the neighbourhood of the magnetic equator in agreement with experiment. A latitude-dependent vertical distribution of the electric currents is obtained which is in good agreement with the results of rocket measurements. J. M. HOUGH

551.510.535

8807. Determination of the altitude and semi-thickness of a regular ionospheric layer, allowing for the action of the terrestrial magnetic field (ordinary and extraordinary rays). E. ARGENCE AND M. MAYOT. *C.R. Acad. Sci.* [*Paris*] **238**, 1721–3 (*April* 26, 1954) *In French.*

Theoretical values for the *F*2 region are compared with measurements made at Fribourg. Virtual heights for the ordinary ray agree well, but show a systematic discrepancy for the extraordinary ray. G. M. BROWN

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 8455–8

551.510.535 : 621.396.11

8808. Passage of a plane aerodynamic wave of half-day period through a plane model ionosphere in a homogeneous magnetic field. I. LUCAS. *Arch. elekt. Übertragung*, **8**, 91–5 (*Feb.*, 1954) *In German.*

The basic equations set up earlier on the basis of plasma theory are applied to the passage of a plane wave through the ionosphere. Frequency and wavelength correspond here to the value of the air oscillations induced in the terrestrial atmosphere by the tidal forces of sun and moon. The solution of the set of equations gives an electromagnetic damping of the air oscillation at particle densities and plasma densities such as are present in the terrestrial atmosphere at heights above 300 km. The electrical conductivity in a horizontal and in a vertical magnetic field is represented as a function of the neutral gas density. A.

551.576

8809. On diffusion from a continuous point source at ground level into a turbulent atmosphere. D. R. DAVIES. *Quart. J. Mech. appl. Math.*, **7**, 168–78 (*June*, 1954).

A theory is developed to predict the turbulent dispersion into the atmosphere of a cloud of air-borne particles of matter, emitted uniformly from a fixed point source at ground level. The method is an extension of one used by Calder [Abstr. 4561 (1949)]. In conditions of neutral atmospheric stability the formula obtained for the distribution of concentration in the important case of aerodynamically rough flow near the surface leads to theoretical results concerning cloud height and width which are in very good agreement with the observational data. A.

551.593.63

8810. The circumsolar halo in infrared rays of the spectrum. E. V. PYASKOVSKAYA-FESENKOVA. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 5, 989–92 (1952) *In Russian.*

Describes the electric photometer used for observations conducted in 1951–52 in Central Asia. Results of measurements show that, as in the visual part of the spectrum [see Abstr. 2377 (1952)] the diurnal variation of the brightness of the halo in the infrared region is independent of the wavelength. Measurements of the relative solar halos as functions of m (mass of the atmosphere in the direction of the sun), made during three non-consecutive days, are graphed as three straight lines passing through the origin. The three gradients are 0·10, 0·82 and 2·40, the lowest value referring to observations in a heated arctic air, while the two others refer to tropical air of different humidity and dust content. [Abstr. 2377 (1952) contains references to the sun's "corona," which are not correct; these should have been translated as "halo." The abstract was consequently wrongly classified under Solar phenomena in Astrophysics, whereas it should have been under Optical phenomena in Atmosphere.] F. LACHMAN

551.593.9

8811. Note on the luminosity of the night sky. J. LENOBLE. *Cahiers de Phys., No.* 49, 67–8 (1954) *In French.*

Results obtained by five different investigators using visual, photographic and photoelectric methods have been reduced to a standard scotopic (visual) scale for intercomparison. The reduced brightnesses vary from $2{\cdot}1 \times 10^{-8}$ stilb [Dufay (1928)] to $16{\cdot}2 \times 10^{-8}$ stilb [Černiajev (1936)]. D. R. BARBER

551.593.9 : 535.338

8812. Nature of active nitrogen. P. K. SEN GUPTA. *Sci. and Culture*, **19**, 414–16 (*Feb.*, 1954).

The basic reactions likely to produce active N_2 with a high degree of probability are reviewed in detail. Mitra's attempt to explain the mechanism of activation (1945) in terms of ionized molecules in the $N_2^+(X')$ state is discounted in view of recent observational evidence of the absence of positive ion-carriers in the Lewis–Rayleigh afterglow (Benson, 1952), and because of the high recombination coeff. of N_2^+ ions (Oldenberg, 1953). It is shown that the main spectroscopic features of the afterglow may best be explained by defining active N_2 as consisting in highly excited metastable N_2 molecules in line with previous suggestions [Saha and Sur (1924); Cario and Kaplan (1928)]. D. R. BARBER

551.594.14

8813. Interpreting background data from scintillation detectors. L. R. SOLON, J. E. MCLAUGHLIN AND H. BLATZ. *Nucleonics*, **12**, 50–3 (*May*, 1954).

An account of observations made on the γ-ray background on the roof of a New York building during the period Aug., 1952, to Feb., 1953. The

detectors were of the scintillation type with a small temperature coefficient which limited the smallness of changes that could be measured. The background was found to be fairly constant apart from rare periods of high or low background which were associated with the presence or absence of precipitation.

L. R. SHEPHERD

551.594.14 : 551.501

8814. Considerations of the suitability of radioactive atomic aerosols as an indicator in meteorological flow investigations. W. HERBST, R. NEUWIRTH AND K. PHILIPP. *Naturwissenschaften*, **41**, *No.* 7, 156–60 (1954) *In German.*

A large increase in radiation from the ground at Wittental (Brunswick), Oct. 18–20, 1951, led to an attempt to trace the increased radioactivity to atom bomb explosions in U.S.A. and the corresponding measurements by Holter and Glasscock at Helena, Montana. For the explosions on Oct. 6, 7 and 14 the probable track of air at the 500 mb level from Helena to Wittental was determined in each case and shown on a chart. It is considered that these explosions were the cause of increased radioactivity at both places. It is considered that systematic investigations should be made on the track followed by radioactive aerosols and their effect on the community of surrounding lands. Their intensive study can be of importance to atmospheric hygiene, isotope technique and investigations of high-level radiation.

R. S. READ

551.594.6

8815. Dependence of integrated duration of meteor echoes on wavelength and sensitivity. D. W. R. MCKINLEY. *Canad. J. Phys.*, **32**, 450–67 (*July*, 1954).

The reflecting properties of short-duration and long-duration echoes from meteor trails are examined. For short-duration echoes only, the observed relation between relative numbers and durations of meteor echoes is independent of wavelength, the time of day, or the presence of a strong shower. Integrated duration times are determined from back-scatter experiments on 9·22 m, 5·35 m and 2·83 m, and are found to vary with the 3·5th power of the wavelength, for either short- or long-duration echoes. The integrated echo power depends on the 6th power of the wavelength. The effect of changing the equipment sensitivity is considered. The data from the back-scatter observations are used to predict the integrated duration times in the forward-scatter case, and in particular, it is shown that the results of the Cedar Rapids–Sterling very-high-frequency experiment may be explained by meteoric reflections. A.

BIOLOGY 57/59

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.841

8816. Light absorption in the crystalline lens of the cat. R. A. WEALE. *Nature* [*London*] **173**, 1049–50 (*May* 29, 1954).

The absorption spectrum of two crystalline lenses from cats was measured and found to differ considerably from that of the human lens. The cat's lenses are colourless. The data are applied to Wirth's ERG sensitivity curve, and found to improve the agreement between this and data on man. They are also applied to Gunter's behavioural data. R. A. WEALE

612.843.611

8817. The position of no accommodation. H. SCHOBER. *Optik*, **11**, *No.* 6, 282–90 (1954) *In German.*

A review of the appropriate literature reveals that when the eye is not accommodated it is not focused for infinity, as frequently assumed, but to a point intermediate to this and the near-point. R. A. WEALE

612.843.613

8818. Dependence of the threshold of the human eye on the duration of the stimuli and the wavelength of light. W. RIEZLER, F. ESPER AND H. MEURERS. *Z. Phys.*, **137**, *No.* 2, 238–55 (1954) *In German.*

Visual thresholds were measured in the fovea and at a point 8° above it in the dark-adapted eye. No mouthpiece was used. The retinal image was about 7 μ in diameter. The data were obtained from frequency-of-seeing curves whose parameter varied from 2–10 quanta (mean: 5·4) in the extra-fovea, and from 2–20 (mean 12) in the fovea. At exposure times longer than 10^{-3} sec these means rose to 7 and 17 respectively (at $t = 0{\cdot}12$ and $1{\cdot}0$ respectively). A simplified model of retinal action led to the result that the summation time is 0·25 sec in the parafovea, and 1·3 sec at the fovea. The wavelength variation of the extra-foveal sensitivity is orthodox, although it agrees with the absorption spectrum of visual purple without being corrected for preretinal absorption [*sic*]; the foveal curve is maximal at 555 mμ but too narrow when compared with curves due to other workers. Van der Velden's work is criticized. In conclusion data on the appearance of colours are presented. R. A. WEALE

PHOTOGRAPHY 77

771.5

8819. The area law in granularity: Theoretical considerations. I. Transmittance and density fluctuations —thickness correction. R. DEBOT. *Bull. Soc. Roy. Sci. Liège*, **23**, 79–89 (*Feb.*, 1954) *In French.*

The area law in granularity, $G = \sigma_{Ta}\sqrt{a}$ is derived on the single assumption that the transmittances of neighbouring areas are independent. σ_{Ta} is the standard deviation of the fluctuations in transmittance of an area a. The standard deviation of density fluctuations σ_{Da} can be calculated in terms of σ_{Ta} on the assumption that the distribution of the transmit-

tance fluctuations is Gaussian. A correction for the thickness of the photographic layer is derived in terms of the numerical aperture of the objective used to image the area a on the photographic material. For a numerical aperture of 0·65 the correction is 40% for a scanning aperture of 4 μ diameter and is less than 1% for a scanning aperture diameter of 350 μ.

A. C. COATES

771.53

8820. A note on scientific photography. H. K. PAETZOLD. *Z. angew. Phys.*, **6**, *No.* 5, 219–21 (1954) *In German.*

The relative sensitivities, and resolving powers of various commercially-available photographic emulsions are discussed in relation to their suitability for qualitative, and quantitative recording of optical images in astro- and spectro-photography.

D. R. BARBER

771.53 : 535.434

Scattering of light by crystals of photographic emulsions. *See Abstr.* 8215

778.33

8821. The use and scope of iridium 192 for the radiography of steel. R. HALMSHAW. *Brit. J. appl. Phys.*, **5**, 238–43 (*July*, 1954).

The radiographic techniques and scope of application of Ir^{192} for the radiography of steel, are discussed. Sensitivities obtainable have been calculated from the experimentally determined effective absorption coefficient and the ratio of scattered to direct radiation intensities; these sensitivities have been confirmed experimentally. An attempt has been made to assign an equivalent X-ray kilovoltage to the radiation. The definition obtainable and its importance with different types of flaw have been discussed, and from this data the ranges of thickness of welds and castings on which satisfactory flaw-sensitivity should be obtained have been suggested. A.

778.33 : 539.166

8822. Memorandum on gamma-ray sources for radiography. *London: Institute of Physics* (1954) 28 *pp.*

A new edition of a memorandum prepared by a Committee of the Non-destructive Testing Group (formerly Industrial Radiology Group) of the Institute of Physics [Abstr. 4079 (1952)]. In addition to the information given in the previous edition on Co^{60}, Ta^{182}, Ir^{192}, Ra and Rn, details are given of the properties and availability of Cs^{137}, Tm^{170}, Na^{24} and Au^{198}. Exposure charts are also given. The sections on Radiographic technique and Protection and handling have been enlarged and the bibliography extended and brought up to date. J. THEWLIS

778.34

8823. Determination of the exact moment when charged particles are recorded in a photographic plate. ZH. S. TAKIBAEV. Letter in *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 363–4 (1953) *In Russian.*

The suggested method consists in placing two plates with emulsions turned toward each other, the lower plate beginning to rotate slowly at a moment T_0. After one full rotation, the clockwork mechanism displaces the upper plate by Δr. This rotation with superposed displacements lasts until time T. Any moment t (between T_0 and T) can be obtained from the equation $T - t = [i + \{(\phi + \phi_0)/2\pi\}]/\omega$, where i is the number of displacements, ϕ_0 and ϕ are azimuths of the track in the upper and lower plate, respectively, and ω is the angular speed of rotation. F. LACHMAN

778.34

8824. Determination of the masses of charged particles in photographic plates by the photometric method. C. MABBOUX AND D. MORELLET. *C.R. Acad. Sci.* [*Paris*] **238**, 1793–5 (*May* 3, 1954) *In French.*

Photoelectric measurements of the grain density of tracks of charged particles in nuclear emulsions have been used to determine the masses of such particles. An accuracy of 7% can be obtained on a single 5000 μ track for a particle whose mass is in the neighbourhood of $1000m_e$ [see Abstr. 8304 (1953)].

A. C. COATES

778.34

8825. The measurement and reduction of distortion in thick emulsions. V. D. HOPPER, Y. K. LIM AND M. C. WALTERS. *Austral. J. Phys.*, **7**, 288–96 (*June*, 1954).

A study has been made of some of the factors influencing the distortion of developed images of tracks in Ilford G5 400 μ emulsions. It has been found that the effect of distortion on scattering measurements can be reduced to a negligible amount by developing the emulsions at 15°c and drying with an alcohol–water solution of increasing concentration. A simple quantitative description of the distortion can be obtained by fitting a sinusoidal series to the curve of a high-energy track traversing the emulsion. A.

778.34

8826. The grain density and the process of track formation in nuclear emulsions. III. Experimental determination of the probability that a grain be rendered developable. M. DELLA CORTE. *Nuovo Cimento*, **12**, 28–36 (*July*, 1954).

For Pt II, see Abstr. 3002 (1954). After consideration of the gap-length distribution, a method is suggested by which the probability that a grain be rendered developable can be obtained experimentally. Following this scheme on the process of track formation, it is also indicated how it is possible to take into account the dip of the track. An example of the application of this method to the mass identification of particles is given. A.